A STUDY OF THE BEHAVIOURAL EXPRESSION OF FEAR AND EXPLORATION IN TWO STOCKS OF DOMESTIC FOWL

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I declare that this thesis has been composed by me and that the work described is my own.

A C K N O W L E D G E M E N T S

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SUMMARY

Two stocks of domestic fowl were studied. They were known to differ in the intensity of withdrawal responses shown towards human beings. Firstly the stimulus components which would elicit withdrawal in birds of various ages were investigated. Factors such as size of the stimulus, distance between stimulus and bird, whether the stimulus was stationary or moving towards or away from a bird and novelty, were all relevant and interacted with each other in a complex manner. With most of the effective stimuli more intense withdrawal was shown by birds of the white (flighty) stock than by those of the brown (docile) stock, regardless of the birds' age. Although birds of both stocks showed habituation of withdrawal to some stimuli, the withdrawal response to human beings never habituated completely in flighty-stock birds, even when a human being was associated with a food reward.

Withdrawal responses are usually classified as part of "fear behaviour" and the two stocks were next compared in a variety of other supposedly fearful situations. Stimuli such as novel environments, novel objects and novel food produced a wide variety of behavioural responses which were related in a complex manner to stock, age and the nature of the stimulus. Further, as well as performing rather obvious fear responses such as running away or emitting alarm calls or peeps, birds often indicated the presence of fear by performing a normal behaviour as a displacement activity, or by adopting an abnormal body posture, such as standing with the beak resting on the ground. It was therefore not possible to compile a single list of fear responses of the domestic fowl in the order of intensity of fear that they represent. In comparing the intensity of fear responses between stocks and between ages, many factors must be considered, including the exact nature of the fear stimulus and the capacity of the birds to perceive it.

Most novel stimuli evoked exploration as well as fear and the two types of response always showed a constant alternation rather than a single change from one to the other. Because fear of a novel stimulus sometimes inhibited exploration of it, there was difficulty in determining whether differences in exploratory behaviour between birds of the two stocks represented differences in exploratory or in fearful tendencies.

The experimental findings clearly indicated that "general fearfulness" or "emotionality" did not exist as unitary traits in the two stocks of domestic fowl studied. Which of the two stocks appeared more afraid varied both with age and with stimulus, although on the whole, flighty-stock birds showed more fear of novel environments and docile-stock birds more fear of novel objects placed in the home environment. Therefore, neither the classification of birds as "fearful" or "fearless" on the basis of their responses in a single situation, nor the selection of a "fearless" strain for commercial use, seem very feasible propositions.

GENERAL NOTES

1. Housing and husbandry of experimental animals

The housing and husbandry common to all birds used in this study is described below. If there were any deviations in a particular experiment these are described in the Materials and Methods section of that experiment.

Hatching The sex of the chicks was determined at the hatchery and they were then transported 6 miles to the laboratory building. ALL BIRDS USED IN THIS STUDY WERE FEMALES. THEY WERE ALWAYS HATCHED AND REARED IN SINGLE-STOCK GROUPS.

0-6 weeks During this time the chicks were brooded in an Eltex "Waldorf" brooder. Each group, which usually consisted of about twenty chicks, had a floor area of 180 by 38 cm. There were eight such compartments in the four-tier brooder. The sides were of 3 mm diameter bars, 2 cm apart and the floor was of 10 mm square mesh. The temperature was 35°C during the chicks' first week after hatching and was thereafter reduced by 2-3°C every week until the ambient room temperature of 18-23°C was reached. Average light intensity in each compartment was rather low, 30 lux. Chick mash and water were available ad libitum in troughs clipped on to the outside of each compartment. At 3 weeks of age chicks were vaccinated against Newcastle Disease.

6-14 weeks During this time birds were kept in communal rearing cages - an Eltex "Spartan Unit". A group from the brooder was transferred to a cage 122 by 70 cm, there being four such cages stacked vertically in each unit. The roof, back and sides of each cage were of galvanised steel and the front of 4 mm diameter bars, 3.5 cm apart;

the floor was of 17 mm square mesh. Artificial heat was not supplied. The average light intensity in the cages was 11 lux. Food and water were available ad libitum in dishes clipped on to the outside of the cages. At about 8 weeks of age the birds' food supply was gradually changed from chicks mash to pelleted food.

14 weeks of age onwards At 14 weeks of age birds were transferred either to pens or to a battery unit. At 16 weeks a second vaccination was given.

Pens Each pen measured 2.4 m square and was flanked either on two sides by another pen and on two sides by a corridor, or on three sides by a pen and on one side by a corridor. In the corner of each pen was a door 80 cm wide. The pen floors were of concrete and covered with wood shavings to a depth of about 2 cm. The walls were of galvanised steel to a height of 106 cm and above this of 45 by 55 mm mesh. Water was supplied in two galvanised steel troughs each 45 by 12 cm which stood against one wall and pelleted food was in a hopper 48 cm high and 37 cm in diameter which stood in the centre of the pen. Nest boxes were not supplied, the birds laying on the floor. Average light intensity in the pens was 50 lux. Between eight and twelve birds were kept in one pen.

Battery Unit A single-sided three-tier battery unit was used. Behind it was a wall and 1.5 m in front of it a row of pens. Each cage was 28 cm wide and 50 cm deep; the height at the front of each cage was 50 cm and at the back 43 cm. The side and back walls were of 6.5 by 1.5 mm mesh and the front of 5 mm diameter bars 5 cm apart. A food trough 16 cm wide and 9 cm deep ran along the outside of the front of the cages; the top of the trough was 16 cm above the cage floor.

Each cage had a nipple drinker at the roof of the back of the cage. Near the top of the front of each cage hung a plastic identification card 6 by 9 cm and brown on the side visible to the bird. Average light intensity in the cages was 75 lux in the top and 22 lux in the bottom row. The birds were always housed one per cage and unless otherwise stated each bird's adjacent cage always contained a bird of the same stock and age.

All of the above accommodation was situated in the same area of the poultry house, thus the general background noise was the same for birds of all ages. A 14h light, 10h dark schedule was used.

Husbandry Every morning birds of all ages were supplied with fresh food and water. The droppings trays beneath the brooder and rearing cages were removed and scraped by hand and those below the battery unit cleaned by a mechanical scraper. Every evening the birds again received fresh food and water. Once every three weeks the wood shavings in the pens were replaced, an operation which took approximately one hour. As this obviously caused some disturbance to the birds, pen-housed birds were never observed until at least four days after their pen was cleaned.

2. Description of particular housing used in experiments

a. Standard chick-box When observations were made on young chicks these were not housed in the brooder but placed on the day of hatching in cardboard boxes, referred to as "standard chick-boxes". Each box measured 32 cm long by 37 cm by 25 cm high, if four or more chicks were kept together a box of twice this length was used. The floor of each box was covered with wood shavings. In two adjacent corners was a glass jar 6 cm high and 6 cm in diameter, one of these contained

water and the other chick mash; unless otherwise stated these were refilled twice daily. Heat and light were supplied continuously by 275 watt bulbs suspended above the boxes at such a height as to keep the chicks at the same temperature as those in the brooder at any given age. Average light intensity in the boxes was 44 lux. Several boxes were kept together in a screened pen in the poultry house; they stood on shelves 90 cm above floor level.

b. Sound-proof room A sound-proof room was used in many experiments. It measured 2.0 by 2.8 m and was situated in an area adjoining the poultry house. Along the back wall of the room was a 90 cm high bench on which a cage, referred to as the "experimental cage", stood. It measured 60 cm in each direction and was of 3.5 by 2.0 cm mesh. Black cloth was draped round the outside of the back and side walls. A 100 watt bulb was suspended 10 cm above the roof of the cage giving a light intensity of 1400 lux in the centre of the cage.

The experimental cage used for chicks under 6 weeks of age (experiment C5) measured 60 by 30 by 30 cm high. The back and side walls were of varnished hardboard and the floor, front wall and roof of 25 mm wire mesh. Heat and light were supplied by overhead 275 watt bulbs arranged such that the temperature was the same as in the chicks' home boxes; this varied with age. The light intensity in the centre of the cage was 1400 lux.

3. Observation technique

When more than a bird's initial response to a stimulus was to be observed a timed recording of all its activities was made on a portable tape recorder. The time, to the nearest second, that each behaviour pattern started and finished was noted. Behaviour patterns which had a

duration of less than 5s were recorded as single incidences. Comfort movements - by which was always meant scratching, shaking or stretching - fell into this category, as did yawning, defaecating, pecking the environment and, sometimes, preening.

4. Analysis of results

The behaviour of the two stocks of birds studied could have differed in the performance of any particular behaviour pattern in either of the following ways:-

a. All or most of the birds of one stock may have performed it while none or only a few of the other stock did so. In this case a statistical comparison of the numbers of birds involved (either by a Chi-Squared Test or a Fisher Exact Probability Test) would most probably reveal a significant difference between the stocks.

b. All or most of the birds of both stocks may have performed the behaviour pattern and there would thus be no significant difference in the numbers of birds involved. But the birds of one stock may have spent much longer in that activity, or in the case of incidences of behaviour performed it more often, than birds of the other stock. In this case statistical comparison of the times or incidences involved (either by Mann-Whitney U-test, a t-test or an analysis of variance) would most probably show a significant difference between the stocks.

Since a difference of type (a) obviously represented a more basic difference between the two stocks than did a difference of type (b) the two stocks were always first compared for any differences in numbers of birds involved in performing any behaviour pattern. Then, in cases in which the numbers did not differ significantly, an analysis of type (b) was carried out.

In those experiments with more than one variable e.g. stock and age, a modified version of the Chi-Squared Test was used when comparing numbers of birds. This was Cochran's (1954) method of combining the results of contingency tables which, provided certain conditions are fulfilled, gives greater accuracy than combining the individual tables before the statistical computations are made.

For those behaviour patterns such as preening, which could be performed either as bouts or incidences the arbitrary time of 5s was chosen as the dividing line between the two. In practice however the vast majority of bouts were always of much longer duration than 5s.

Detailed results of most of the experiments are presented as tables in an Appendix. These tables have the suffix A when mentioned in the text.

INTRODUCTORY SECTION

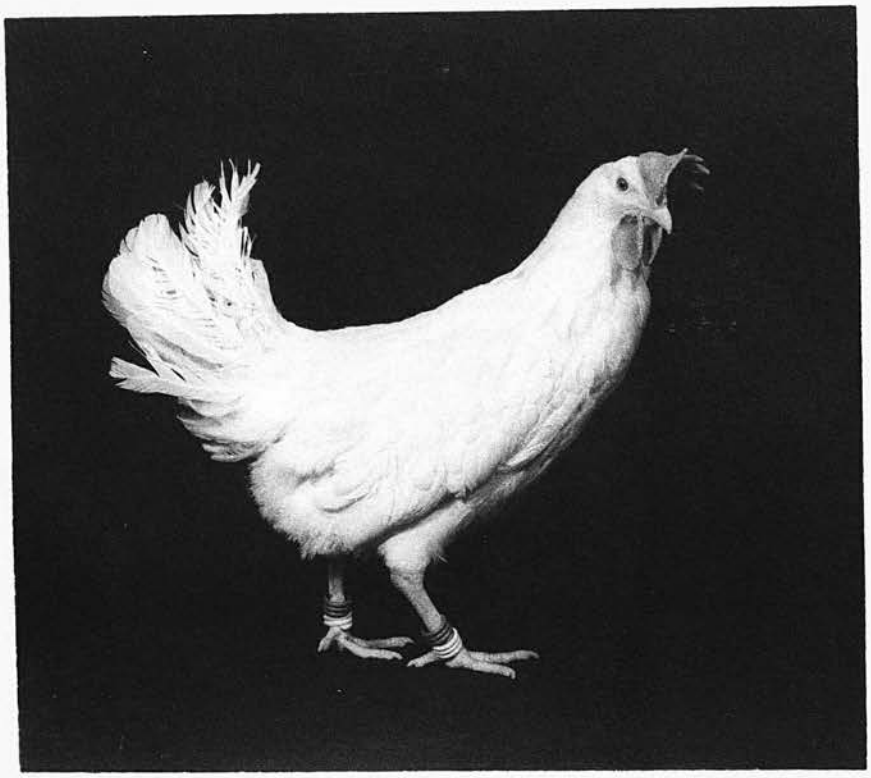
Background to the present study

Present-day breeds of farm stock are defined by breed societies on the basis of morphological characters such as body size and shape, coat colour, length of wool, presence or absence of horns etc. Breeds also frequently differ from each other in behavioural characters even although conscious selection for these characters may never have been practised. For instance amongst cattle, bulls of certain breeds are more aggressive and difficult to handle than those of others; amongst horses, Shires are more placid than Arabs. There are many possible ways in which such correlated changes of physical and behavioural characters could have occurred. At a chromosomal level they include pleiotropy and linkage (Fuller and Thompson 1960): at a physiological level they may be concerned with, for example, hormone levels or metabolic rate.

Domestic fowl (Gallus gallus domesticus) , unlike most other species were not originally used as a food source by Man but were kept for religious and sporting purposes and there is evidence that distinct breeds existed in Roman times (Wood-Gush 1959). The main physical characteristic used to distinguish present-day breeds of domestic fowl is body shape (Jull 1952). Behavioural differences between breeds have also been described, including susceptibility to broodiness (Burrows and Byerly 1938), effects of androgen injections on dominance-subordinance (Allee et al 1955), general scariness (Tinbergen 1957), and aggressiveness (for review see Womack, Tindell and Craig 1966).

Fowls conforming to breed standards are nowadays generally kept only for show purposes. All commercial stock originates from heavily

Plate 1



A mature white-stock bird

A mature brown-stock bird.

selected strains, these being derived from individual breeds or from crosses between several breeds. Several strains each selected for a particular production character such as egg number or food conversion efficiency are then crossed together to produce the so-called hybrids which appear on the commercial market. The behaviour of various commercial hybrids has been studied and significant differences found in, for example, agonistic behaviour (Choudary and Craig 1972) and the incidence of feather pecking and cannibalism (Hughes and Duncan 1972, Duncan and Hughes 1973).

The subjects of the present study were domestic fowl originating from two different commercial hybrids. Birds of both hybrids were obtained from commercial sources at the same time and were kept as closed flocks at the Poultry Research Centre in Edinburgh for several generations. They therefore probably differed in some respects from the original commercial stock. The "white-stock" birds were from a commercial light-weight hybrid derived from the White Leghorn breed. Mature hens of the Edinburgh flock weighed approximately 2000 g and laid approximately 235 eggs in a year. The "brown-stock" birds were from a commercial medium-weight hybrid derived from a cross between Light Sussex and Rhode Island Red breeds. Mature hens weighed approximately 2400 g and laid approximately 204 eggs in a year. See Plate 1.

Birds of the two Edinburgh stocks differed from each other in certain behavioural characters. Wood-Gush (1972) studied their pre-laying behaviour in battery cages; birds of the white stock appeared to be generally frustrated in this situation and paced a great deal whereas birds of the brown stock showed less evidence of such frustration. The two stocks were also found to differ significantly

Plate 2

Typical responses of mature birds of the two stocks after a person has just entered the home pen.

White-stock birds - attempting to flee from the person.

Brown-stock birds - either ignoring or approaching and looking at the person.

in the incidence and extent of feather pecking occurring during rearing (Hughes and Duncan 1972, Duncan and Hughes 1973). Yet a further difference existed which may best be described as one of temperament. Mature birds of the white-stock were generally extremely flighty and flapped and squawked when disturbed by human beings. This general flightiness or scariness in birds of White Leghorn origin is very common (Tinbergen 1957, Ferguson 1968). The brown-stock birds on the other hand were extremely docile and easy to handle. Plate 2 illustrates typical responses of birds of each stock after a person has just entered their home pen.

"General flightiness" is an undesirable trait for several reasons:-

1. The flighty behaviour fits well the description of the "fight or flight" syndrome which is the first response in a stressful situation (Selye 1950). Stress has been defined by Selye as a physiological state in an animal occurring as a result of its interaction with noxious stimuli in the environment. The suggestion has been made that prolonged arousal of the "fight or flight" mechanism in fowls will result in a shunting of the blood supply away from the visceral organs including the oviduct and lead to a decrease in both the rate of egg production and egg quality (Draper and Lake 1967). In addition to the economic viewpoint is it morally justifiable to maintain farm stock under conditions which appear to be stressful to them?

2. The birds may experience considerable energy loss as a result of their heightened activity when in a flighty state. This may be compensated for by an increase in food intake and hence an increase in maintenance costs.

3. Their flighty nature makes them unpleasant stock to work with, especially where the large numbers of commercial enterprises are involved.

The existence of this flighty response pattern in mature birds of one stock but not in the other posed several questions:-

1. What was the precise nature of the stimuli which would elicit the response in the white-stock birds?

2. At what age did the flighty response pattern first appear?

3. Did the brown-stock birds ever exhibit the flighty response, and if so, under what conditions?

4. Could the response be modified in its intensity or even completely abolished in the white-stock birds?

5. Did birds of the two stocks differ in any other aspects of their behaviour which may have been related to and/or accounted for the differences in flightiness shown towards human beings?

The present study attempted to answer these questions. The results are presented in five sections.

Section A verified quantitatively that mature white-stock birds were more flighty in their response to human beings than were mature brown-stock birds.

Section B determined the age at which the flighty response first appeared and also a preliminary investigation was made into the stimulus situation which would elicit it. The flighty response was classified under the broad spectrum of "fear behaviour".

In Section C a wide survey of fear behaviour in birds of the two stocks was made. During this, the general problem of distinguishing and ranking fear behaviour and exploratory behaviour was met and was discussed at length.

In Section D two different attempts were made to modify the flighty response in the white-stock birds; firstly through a process of associating handling with a food reward and secondly by controlling the birds' early experience with human beings.

In Section E a search was made for differences between the two stocks in other aspects of their behaviour which may have been related to and/or accounted for the difference in flightiness.

But firstly the behaviour of birds of the two stocks was observed while they were undisturbed in their home environment. The results are described below.

Experiments I 1 and I 2

General Introduction Behavioural comparisons are frequently made between different sexes, different ages or different strains of animals within a species. One aspect often forgotton in such studies is how these different animals differ in their behaviour when not subjected to the experimental manipulation under consideration. Take as an example the ambulatory activity of an animal confined in a strange environment. There is much controversy about whether differences found in the number of floor units crossed indicate different levels in the underlying motivational states of fear, or of exploration. It is, however, also entirely possible that in any situation, regardless of underlying motivational state, the animals of one group (defined by age, sex etc) will move about more than animals of the other. Conversely, a lack of differences in response in an experimental situation need not imply equality of underlying motivational state. Using the same example, if two groups differ greatly in movement when undisturbed in their home environments but do not do so when placed in a strange environment this indicates a difference in their responses to the strange environment.

In the measurement of fear - or exploration - motivated responses it is not always possible to make control observations. Responses such as fixating, pecking or withdrawing obviously cannot be performed in the absence of a stimulus object. It was decided that the most suitable control for all the following experiments would be to observe the behaviour of both chicks and mature birds of the two stocks, whilst undisturbed in their home environment, and to measure and compare the quality and quantity of all behaviour patterns shown.

Experiment I 1

Introduction Previous studies have shown the undisturbed behaviour of chicks in their home environment to be little affected by whether they were reared in visual isolation or as members of a social group (Broom 1968, Hogan 1971). Thus in the present study, for ease of observation, only chicks reared in isolation were used.

Materials and Methods Thirty-six different chicks of each stock were observed; twelve at each of 4, 7, and 14 days of age. They were housed individually in standard chick-boxes. At each experimental observation two chicks of the same age but of different stocks and housed in adjacent boxes were observed simultaneously. The observation period was 2h during which a timed record was made on a portable tape recorder of each chick's activities. Equal numbers of chicks of each age were observed during each of the four 2h periods between 9 am and 5 pm.

On days when observations were not made the experimenter spent two separate half-hour periods sitting in the centre of the pen overlooking the boxes. Although chicks of the ages concerned

never showed any obvious signs of perceiving the experimenter this procedure ensured that during the experimental observations the chicks would not be exposed to any form of novel stimulation.

Analysis From the observations the total time spent by each chick in each behaviour pattern recorded was calculated. Time spent standing plus time spent lying accounted for the entire 2h, as did time with eyes closed plus time with eyes open, and also time with beak on ground plus time with beak off ground. All time spent not engaged in any definable activity such as eating, preening or eyes closed was classed as "Idle time". Thus the sum of the following mutually exclusive activities also accounted for the entire 2h:- idle, eyes closed, eating, drinking, preening, litter pecking, pacing, dust-bathing, pecking the environment. Incidences of behaviour patterns with duration less than 5s were also counted e.g. changing stance, preening and defaecating.
Statistical comparisons between the two stocks and three ages were made by analysis of variance.

Results

1. Behaviour patterns performed as bouts of >5s duration

The proportion of time spent in various activities was found to vary much more with age than with stock. There were however some significant age x stock interactions. Chicks of all age-stock classes spent approximately one half of the total time standing and one half lying. The time spent with eyes closed (which occurred in both lying ; and, less commonly, standing chicks) &also the time spent with beak on the ground (lying chicks only) were both significantly less in older chicks than in younger ones ($p < 0.001$). For both of these behaviour patterns the decrease between days 4 and 7 did not

Figure I 1

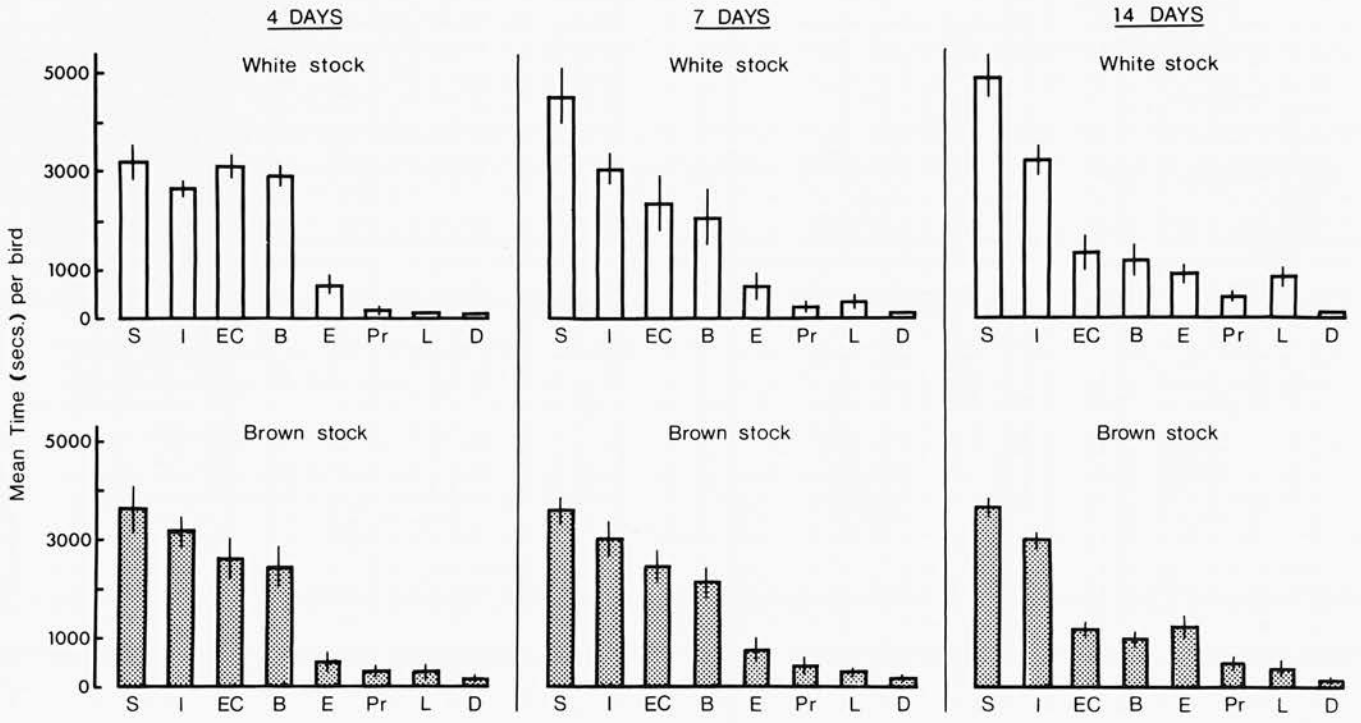
Exp. I 1

Behaviour of chicks observed undisturbed in the home environment for 2h.

The mean ± SE times (in seconds) of performance of the most commonly occurring behaviour patterns, by chicks of each stock-age class.

N = 12 chicks in each class.

S = Standing
I = Idle
EC = Eyes closed
B = Beak on ground
E = Eating
Pr = Preening
L = Litter pecking
D = Drinking



reach statistical significance whereas that between days 7 and 14 did ($p < 0.01$). Times spent with eyes closed and with beak on ground showed the greatest difference with age of any of the behaviour patterns recorded. The mean times, in both cases, fell from approximately 3,300s at 4 days of age, to 1,000s at 14 days of age.

The time classed as "idle" remained virtually constant in both stocks at the different ages. It accounted for approximately one half of the total observation period. Since idle time did not alter with age the lesser time spent with eyes closed in the older chicks must have been compensated by more time spent either preening, eating or litter pecking, these being the three activities which occupied nearly all the chicks' time awake. Drinking, dust-bathing and pacing all occupied a negligible amount of time. The mean times spent eating, preening and litter pecking were in fact significantly greater in the older chicks than in the younger ones (eating and pecking litter $p < 0.01$, preening $p < 0.05$). The increase in litter pecking with age occurred mainly in the white stock and the age x stock interaction was significant at the 5% level.

The only behaviour pattern in which the times differed significantly between stocks was preening; the brown-stock chicks spent significantly longer in this activity than the white-stock chicks ($p < 0.05$).

Of these three activities - eating, preening and litter pecking - the greatest mean time in each of the six stock-age classes was spent eating; the relative proportions of the other two was not constant. Figure I 1 shows the mean $\pm$ SE times spent in each of the eight most commonly occurring activities. The great similarity between the two stocks at each age and the differences between the three ages

Figure I 2

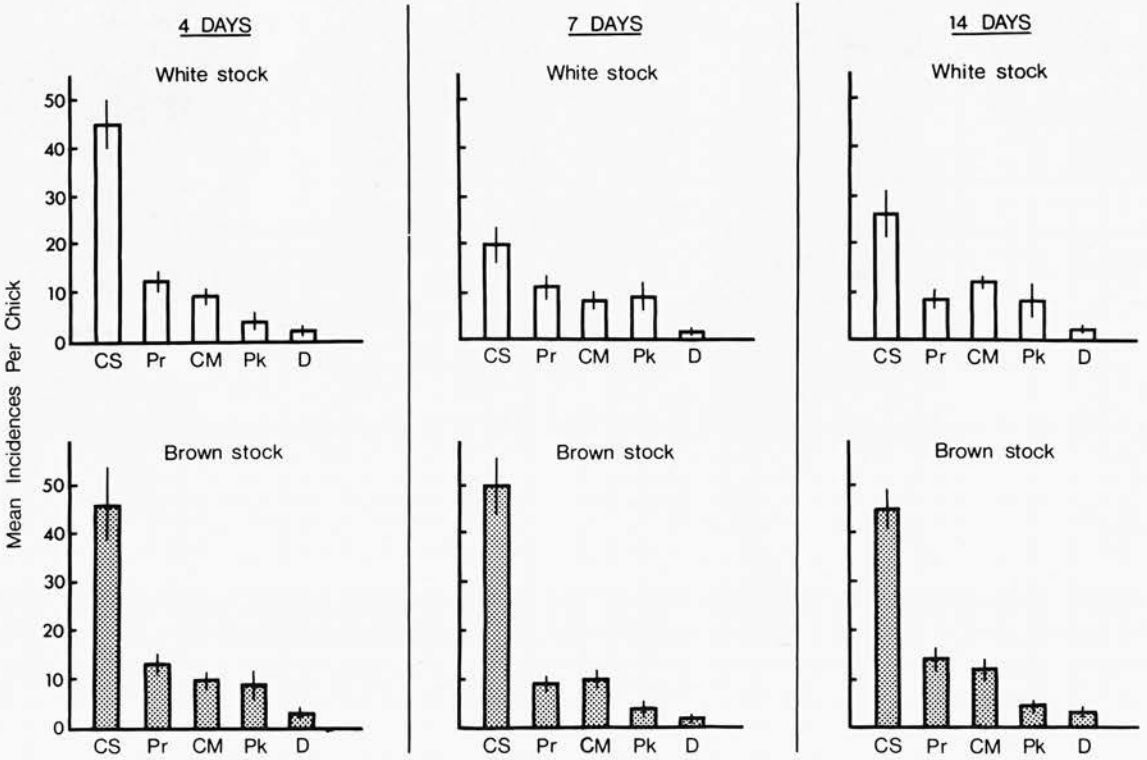
Exp. I 1

Behaviour of chicks observed undisturbed in the home environment for 2h.

The mean ± SE incidences of performance of five different behaviour patterns, by chicks of each stock-age class.

N = 12 chicks in each class.

CS = Change stance
Pr = Preen
CM = Comfort movement
PE = Peck environment
D = Defaecate



are clearly seen here. The results of the analysis of variance are given in Table I 1 A.

2. Behaviour patterns performed as incidences of $\angle$ 5s duration

Five such behaviour patterns were performed:-

Changing stance brown-stock chicks changed stance more often than white-stock chicks ($p \angle 0.001$), but there was also a significant age x stock interaction ($p \angle 0.001$). The mean incidences remained constant with age in the brown stock but were much less in the white stock at 7 and 14 days than at 4 days.

Defaecation The mean incidence of defaecation ranged only from 2.1 ± 0.5 to 3.1 ± 0.5 between the six stock-age classes. There were no significant differences due to stock or age.

Peck environment Incidence of pecking the environment were greater in older chicks than younger ones in the white stock chicks but less in older chicks in the brown stock This resulted in a significant age x stock interaction ($p \angle 0.05$).

Preening There were no significant age or stock differences.

Comfort Movements There were no significant age or stock differences.

Figure I 2 shows the mean $\pm$ SE number of incidences that each of the above behaviour patterns were performed. The results of the analysis of variance are given in Table I 1 A.

Table I 2 A lists the entire range of behaviour patterns observed and the number of chicks performing each.

Discussion The results showed that, at least in the home environment used, the behaviour of undisturbed isolated chicks varied much more with age than with stock. Hogan (1971) observing the behaviour of undisturbed Jungle Fowl chicks found similar age-related variations;

the percentage times spent pecking and ground-scratching increased with increasing age during the first two weeks after hatching whilst the percentage time spent sleeping decreased. A further similarity between Hogan's study and the present one was the age at which dust-bathing was found to first occur - around 14 days. It thus seems probable that this age-related change in the proportions of time spent asleep and active is a general one in the genus.

It is very interesting that chicks of all ages spent approximately one half of the total time awake, but not engaged in any definable activity i.e. in "idle" time. It demonstrates well the point made earlier that when observing an animal's behaviour one subconsciously attaches inflated importance to the occurrence of events one is expecting or hoping to observe.

Another result worthy of special note was the incidence of defaecation. With three exceptions, all the chicks defaecated at least once during the 2h period; the mean number was between two and three defaecations per chick. This figure has relevance in its use as a base line when considering the incidence of defaecation in Open Field and similar tests.

Experiment I 2

Introduction In this experiment the undisturbed behaviour of mature birds housed either in pens or in battery cages was observed.

a. Pen-housed birds

Subjects Two pens were observed; one containing twelve white-stock and the other twelve brown-stock birds. At the time of observation the birds were 8 months old and had been housed as closed flocks for 4 months.

Methods One week before the observations began the experimenter spent half an hour each morning and afternoon standing outside the wall of each pen to allow the birds to become accustomed to her presence. All the birds were in lay and since it was not desirable that pre-nesting activity should interfere with the performance of all other activities the following procedure was adopted for making the experimental observations. The experimenter observed a pen of birds between 9 am and 10 am noting which birds laid during this time. One of these was then chosen at random and its undisturbed behaviour observed between the hours of 4 pm and 6 pm on the same day. (At this time there was also a minimum of environmental disturbance in the poultry house). Birds of the two stocks were observed on alternate days.

Analysis The total time spent by each bird in each of the behaviour patterns recorded was calculated. Time spent standing plus time spent lying accounted for the entire 2h period, as did the sums of the following times - eating, drinking, preening, pecking floor litter, dozing, dust-bathing and idle. (Dozing was performed either standing or lying, the birds continuously opened and closed their eyes but never tucked their heads behind their wings in the true sleep posture. Idle time was defined as in the previous experiment). Incidences of

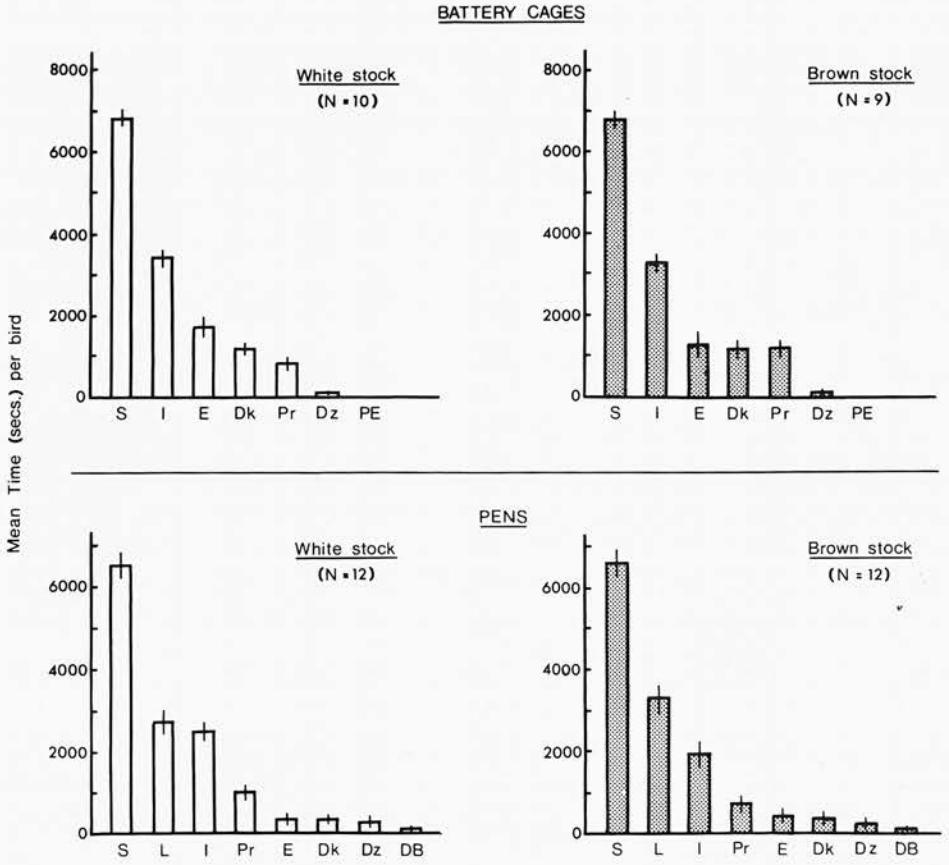
Figure I 3

Exp I 2

Behaviour of 8-month old birds housed either in battery cages or in pens and observed undisturbed in the home environment for 2h.

The mean ± SE times (in seconds) of performance of the most commonly occurring behaviour patterns.

S = Standing
L = Litter pecking
I = Idle
Pr = Preening
E = Eating
Dk = Drinking
Dz = Dozing
DB = Dust bathing
PE = Peck environment



behaviour patterns with duration less than 5s, such as pecking the environment and defaecating, were also counted.

Comparisons between stocks were made by Mann-Whitney U-tests, 2-tailed.

Results

1. Behaviour patterns performed as bouts of $\geq$ 5s duration

Birds of the two stocks spent very similar proportions of their time in each of the various behaviour patterns observed and there were no significant stock differences. Approximately 90% of the time was spent standing, indeed only five flight-stock and four docile-stock hens spent any time lying. The most commonly occurring activity in both stocks was pecking the floor, the mean times out of a possible 7200s being 2736 $\pm$ 256s (flighty stock) and 3327 $\pm$ 300s (docile stock). Idle time was the next commonest in both stocks followed by preening. Each of the above activities were performed by all the birds of each stock. Eating and drinking occupied much less of the birds' time and were not performed by all the birds. Dozing and dust-bathing were even less frequent in occurrence.

Figure I 3 shows the mean $\pm$ SE times spent by all birds of the two stocks in performing each behaviour pattern.

2. Behaviour patterns performed as incidences of $<$ 5s duration

Only four such behaviour patterns were observed. These were preening, comfort movements such as stretching and scratching, pecking the environment, and defaecating. They all had a very low level of occurrence and there were no significant stock differences. The number of birds performing each and the mean $\pm$ SE incidences of performance are given in Table I 3 A.

b. Battery-housed birds

Subjects Ten white-stock and nine brown-stock birds were observed. At the time of the experiment the birds were 8 months old and had been housed in the top tier of the battery unit for 4 months.

Methods and Analysis The same procedure was used as for the pen-housed birds. Observations were made from behind the wire mesh wall of a pen 1.5 m in front of the battery unit. Litter pecking was of course not possible but birds sometimes spent periods pecking at the bars of the cage or other parts of the environment.

Results

1. Behaviour patterns performed as bouts of $>$ 5s duration

Again birds of the two stocks spent very similar proportions of their time in each of the various behaviour patterns observed and there were no significant stock differences. Most of the time was spent standing, with only six white-stock and five brown-stock birds lying at any time. Easily the greatest proportion of the time was spent idle, the mean values being 3437 $\pm$ 203s (white stock) and 3310 $\pm$ 199 (brown stock) - just under half of the total time. Eating, drinking and preening each occupied equivalent amounts of time, approximately 10-20% of the total and all the birds except one of the white stock which did not preen, performed each of these three behaviour patterns. Only four birds of each stock spent any time dozing and only two white-stock and three brown-stock birds pecked at the environment.

Figure I 3 shows the mean $\pm$ SE times spent by the birds of each stock in each of the above activities.

2. Behaviour patterns performed as incidences of $\angle$ 5s duration

The occurrence of preens, comfort movements, defaecations and pecks at the environment were rather infrequent and did not differentiate the two stocks: see Table I 3 A.

SECTION A

Introduction

The experiments in this section were designed to demonstrate quantitatively that mature birds of the white stock were more flighty, and those of the brown stock more docile in their responses towards human beings. For this purpose three different stages of bird - human being interaction were differentiated. These were firstly the presence of a stationary human being in the immediate vicinity of a bird; secondly the approach of a human being, with arms outstretched, towards a bird; and thirdly the handling of a bird by a human being. The responses of both pen-housed and battery-housed birds were measured.

N.B. Different birds were used in each experiment and all were approximately 9 months of age.

1. Battery-housed birds

Experiment A 1

Object To compare the responses of mature battery-housed birds of both stocks to the presence of a stationary human being.

Materials and Methods Twenty-four laying birds of each stock were observed. They were not accustomed to being handled but were exposed to a fairly constant passage of human beings throughout the day.

The criterion used for selecting a particular bird for observation was that she be standing at the front of the cage facing outwards and not obviously engaged in any particular activity. Whilst apparently walking past the cage of this bird, the experimenter stopped in front of it and turned to face it. The bird's immediate

Plate 3

Typical responses of mature birds of each stock when a person stood in front of the home battery cages.

On the left, two brown-stock birds with their heads out at the front of the cages close to the person. On the right, a white-stock bird turns to face the back of the cage away from the person.

response was noted. Responses were given a score along a scale in which score 1 represented the maximum withdrawal shown and score 6 the maximum approach towards the experimenter:-

1. Turned and ran to back of cage.
2. Turned and walked to back of cage.
3. Took one or two steps backwards.
4. Stood still.
5. Pushed head out between front bars of cage.
6. As for 5 above, but also raised one foot up onto the front bars.

Observations were carried out over a period of 2 weeks so that neighbouring birds would not be observed on the same day.

Results The birds of the white stock obtained substantially lower scores, more withdrawal, than those of the brown stock. The mean scores were 1.9 ± 1.1 (white stock) and 4.6 ± 0.2 (brown stock), $p < 0.001$, Mann-Whitney U-test, 1-tailed. The two lowest scores, maximum withdrawal, were obtained only by white-stock birds and the two highest scores, approach, only by brown-stock birds. Plate 3 shows typical responses of birds of the two stocks when a person stood in front of the cages.

The data for this experiment are shown in Table A 1 A.

Experiment A 2

Object To compare the responses of mature, battery housed birds of the two stocks to (a) human approach and (b) human handling.

Materials and Methods Twenty-four laying birds of each stock were observed. The same experimental method was used as in the previous experiment except that as the experimenter turned to face the bird's cage she also placed her hands on it, opened it, reached in for the bird with both her arms outstretched and lifted the bird up. One half of the birds of each stock were lifted by placing the hands firmly on the bird's sides with the thumbs almost meeting on the centre line of the bird's back and the tips of the fingers on the keel of the breastbone. The other half were lifted in a much less firm manner by holding the two wings, in the area of the humerus bone, in the right hand; the bird's body not being grasped at all.

Each bird's responses were noted by memory (a) as the experimenter reached into the cage approaching the bird and (b) as the bird was being lifted off the cage floor. The seven mutually exclusive responses given to the experimenter's approach were scored as follows:-

1. Panic - undirected jumping around cage, accompanied by loud squawking.
2. Turned and jumped up at back of cage.
3. Turned and walked to back of cage.
4. Took one or two steps backwards.
5. Stood still.
6. Extended head and neck forwards towards approaching hand.
7. As for 6 above, but also pecked hand.

A maximum of two birds per stock per day were observed and these were always housed at least three cages apart.

Results

a. Approach of human being The birds of the white stock obtained much lower scores, more withdrawal, than those of the brown stock. The mean scores were 2.4 $\pm$ 0.2 (white stock) and 5.3 $\pm$ 0.3 (brown stock) $p < 0.001$, Mann-Whitney U-test, 1-tailed. As in the previous experiment the lowest scores were obtained only by white-stock birds and the highest only by brown-stock birds.
The data are shown in Table A 2 A.

b. Handling by human being All birds of the white stock struggled and squawked when they were first grasped but all became quiet and motionless as soon as they were lifted clear of the cage floor. Six birds of the brown stock struggled very slightly as they were grasped and fifteen of them clucked loudly at this time; they also became quiet and motionless when lifted off the floor. The method of grasping the birds had no effect whatsoever on their responses.

2. Pen-housed birds

Experiment A 3

Object To compare the responses of mature, pen-housed birds of both stocks to the presence of a stationary human being.

Materials and Methods Twenty-two laying birds of each stock were observed. They were accustomed to human beings moving around inside the pen, but were unaccustomed to being handled.

A pilot study showed that interactions between birds were obviously interfering with the distance that any one bird was trying to maintain between itself and the experimenter. Thus for the purposes of this experiment birds were isolated in pairs in a nearby, though not adjacent, pen which was identical to the home pen. Pairs of birds were chosen which were close to each other in the peck-order; previous observations

having shown that such a pairing resulted in minimal agonistic encounters between the two birds. Although isolating the birds necessitated handling them this isolation was essential for obtaining unbiased results. After isolation some time was allowed for the birds to recover from the handling procedure and adapt to their new social environment. Each pair was isolated in the early morning of day 1 and observed in the late afternoon of day 3, by which time all egg-laying activity had ceased for the day. During the 3 days before observation the routine daily visits to the pen were carried out as usual, but by the experimenter instead of the usual technical staff.

The observations were made at the time of the last routine visit of day 3, in the following way. The experimenter entered the pen and stood motionless in the corner by the door facing across the pen for 3min. Each of the remaining three corners was in turn occupied for 3min after which the experimenter left the pen. This procedure was designed to minimise any effects of birds' preferences for any particular area of the pen.

Using the panels of the pen walls as markers the experimenter was able to note, on a portable tape-recorder, the relative positions of the birds in the pen with respect to the corner in which she was standing. Four areas were defined, area 1 being closest to and area 4 farthest from, the Experimenter. The total time spent by each bird in each area during the 12min observation period was calculated from the recorded observations. The actual number of steps taken by one of the birds of each pair, chosen by tossing a coin, was counted on a hand counter. When the Experimenter moved from one corner to another she noted whether the birds also moved or if they remained standing still.

Figure A 1 Exp A2

Behaviour of 9-month old birds when a human being was standing in a corner of their home pen for 720s.
The number of birds of each stock entering each of the four areas of the pen and the mean ± SE time (in seconds) per bird spent there for each stock.
N = 22 birds in each stock.

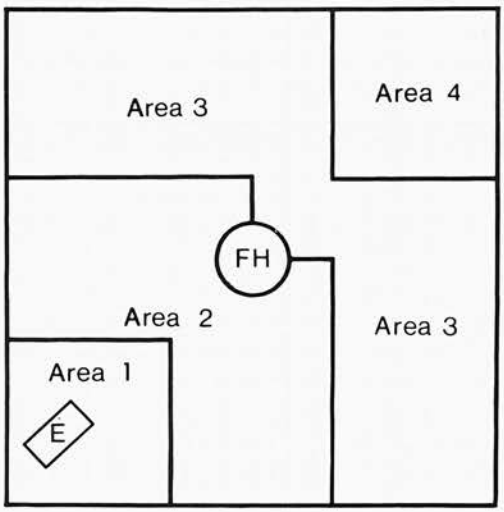
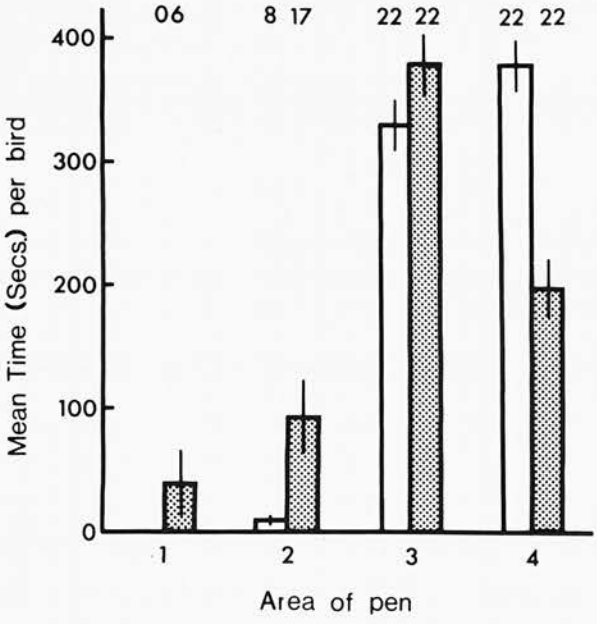


DIAGRAM OF PEN

Scale : 1 : 38

E = Experimenter

FH = Food hopper



No. of birds entering each area.

White stock

Brown stock

Results There were considerable differences between the two stocks in the proportions of time spent in each of the four areas of the pen. Area 1, the area closest to the experimenter, was entered by six different brown-stock birds but no white-stock birds. Area 2 was entered by seventeen brown-stock birds, but only eight white-stock birds ($X^2 = 5.92$, $p < 0.02$). All the birds of both stocks entered areas 3 and 4. There was no significant stock difference in the time spent in area 3, but birds of the white stock spent significantly longer than birds of the brown stock in area 4, the area farthest from the experimenter ($p < 0.001$, Mann-Whitney U-test, 1-tailed). Figure A 1 shows a plan of the pen divided into the four areas together with the mean times spent in each by birds of the two stocks.

In the presence of the experimenter the birds of the white stock moved around more than those of the brown stock. The mean $\pm$ SE number of steps taken by the birds were 290.3 ± 43.9 (white stock) and 109.4 ± 10.8 (brown stock), $p < 0.001$ Mann-Whitney U-test, 1-tailed. The white-stock birds also moved more often than those of the brown stock when the experimenter moved across the pen. Out of a maximum of three possible occasions the means $\pm$ SE were 2.5 ± 0.5 (white stock) and 1.8 ± 0.2 (brown stock), $p < 0.05$ Mann-Whitney U-test, 1-tailed.

Experiment A 4

Object To compare the responses of mature pen-housed birds of both stocks to (a) approach of and (b) handling by, a human being.

Materials and Methods Twenty-four laying birds of each stock were observed. The nature of the observations made in this experiment enabled birds to be observed in their home pens. For three days before the first observation was made in each pen and throughout the experiment all routine visits to the pen were made by the experimenter instead of the usual technical staff.

The bird for observation was chosen at random from a list and could be identified by coloured leg bands. At the time of the last routine daily visit to the pen the experimenter waited outside the door until the selected bird was standing in the corner diagonally opposite it. The experimenter then entered the pen, walked straight across towards the bird, bent down reaching towards it and lifted it up by grasping it firmly with one hand on either side.

The response of each bird was noted by memory (a) as the experimenter reached towards it and (b) as it was being lifted off the pen floor. Since this whole procedure caused some disturbance in a pen, especially to the white-stock birds a maximum of one observation per day and four per week were made in any one pen.

Results

a. Approach of human being When approached birds either stood still or ran away. While nineteen white-stock birds ran away only four brown stock ones did so ($X^2 = 16.36$, $p < 0.001$).

Handling by human being Birds were seldom able to run more than three or four paces before they were grasped. All the white-stock birds struggled and squawked as they were being grasped; eight brown-stock birds struggled slightly. All birds became quiet and motionless as they were lifted clear of the ground.

Discussion of experiments A 1 - A 4

These four experiments confirmed quantitatively the subjective impression that mature birds of the two stocks differed in their responses to human beings. Birds of the white stock were characterised by active withdrawal from human beings and those of the brown stock either by standing still or by active approach. Birds of the two stocks showed rather different responses when handled and the most obvious explanation for the different responses to stationary and approaching human beings was that these were related to different levels of aversion to handling. But several factors pointed against this explanation. Firstly, was it certain that the different responses to handling did in fact represent different levels of aversion? The white birds characteristically squawked while the brown ones clucked. Both vocalisations obviously indicate distress but it is not possible to categorically state that one indicates more distress than the other. Although theories have been proposed concerning the causation of chick vocalisations (Andrew 1964) little seems to be known about this aspect of adult calls. A lack of struggling, as was typical of brown-stock birds, certainly cannot *a priori* be taken to represent a lack of distress. Becoming limp and immobile on being seized by a predator has for centuries been recognised as a very common response in a wide variety of species (Hoagland 1928). In the present experiment all birds of both stocks became motionless as soon

as they were lifted clear of the ground. If this was the "seized-by-predator response" perhaps it was elicited in the brown-stock birds at a lower threshold, i.e. when first seized, than in the white-stock birds which only showed it after losing contact with the ground.

A second reason why it was unlikely that anticipation of being handled was causing birds to withdraw from the experimenter was that the birds had never been regularly handled. In fact the battery-housed birds had never been handled at all for several months. Thirdly there were no great differences between the battery-housed birds, and the pen-housed birds which had been handled three days previously. If recent handling influenced responses to stationary or approaching human beings then there should probably have been differences in the responses of these two groups.

In view of the above it seems that the flighty response of the white-stock birds to an approaching human being was a response to some aspect of that approach and not to some stimulus associated with the anticipated further behaviour of that human being. "Approach" as a stimulus situation is discussed at the end of Section B.

But why did the white birds also withdraw from a <u>stationary</u> human being? There are at least two possible explanations. A person standing about 75 cm in front of a cage was possibly already encroaching upon the flight distance of a bird standing at the front of that cage. In this case it must be assumed that white birds had not developed zero flight distances to Man, whereas most of the brown birds had done so. Or it might have been that this close proximity of a human being was alone not a sufficient stimulus to elicit withdrawal but that, as a natural consequence of the birds' daily experiences, a stationary person had become a conditioned stimulus

eliciting the same withdrawal responses as did the unconditioned stimulus of an approaching person. Since none of the birds had experience of only stationary human beings it was not possible at this stage to assess the validity of this explanation; an attempt to do so is made in experiment D 3.

The above two explanations are not mutually exclusive, either on the whole or for any one bird. Flight distance is a property of the individual rather than of a species or a stock and within any one individual it undoubtedly varies both with external and internal factors. Thus while some birds may have been withdrawing from the stationary person because of encroachment upon their individual flight distance, others may have been associating the stationary person with one about to approach and yet others may have withdrawn for both reasons.

S E C T I O N B

Introduction

In this section birds of successively younger ages were observed to determine the age at which the flighty response pattern first appeared in the white-stock birds. The exact nature of the stimulus which would elicit the response was investigated and possible reasons discussed for the relative lack of flightiness in mature brown-stock birds. The literature on the development of withdrawal responses in precocial chicks is reviewed.

Experiment B 1

Object To compare the responses of 16-week old, caged birds of both stocks to (a) the presence of a stationary human being, (b) human approach and (c) human handling.

Materials and Methods Sixteen birds of each stock were observed. One week before observation they were transferred from the communal rearing cages to individual battery cages, birds from the same rearing cage being placed in adjacent battery cages. The birds were not handled again until the time of the experiment.

The procedure of experiments A1 and A2 was followed except that now the same birds were used to measure all three responses i.e. to human presence, approach and handling. The experimenter stopped in front of a cage, mentally noted the bird's response and then waited 5s before opening the cage to approach and handle the bird. All birds were lifted by placing both hands firmly around the bird's body as described in experiment A2. Responses were scored as in experiments A1 and A2.

Results

a. Presence of stationary human being The distribution of scores between the two stocks of 16-week old birds was very similar to that of the mature birds. Responses 1 and 2, active withdrawal were shown only by white-stock birds whose mean score was 1.8 ± 0.3. Responses 5 and 6, active approach were shown exclusively by brown-stock birds whose mean score was 4.3 ± 0.2 ($p < 0.002$, Mann-Whitney U-test, 2-tailed).

The data are shown in Table B 1 A.

b. Approach of human being Birds of the white stock obtained significantly lower scores, mean = 1.1 ± 0.1, than those of the brown stock, mean = 4.4 ± 0.4 ($p < 0.002$, Mann-Whitney U-test, 2-tailed.)

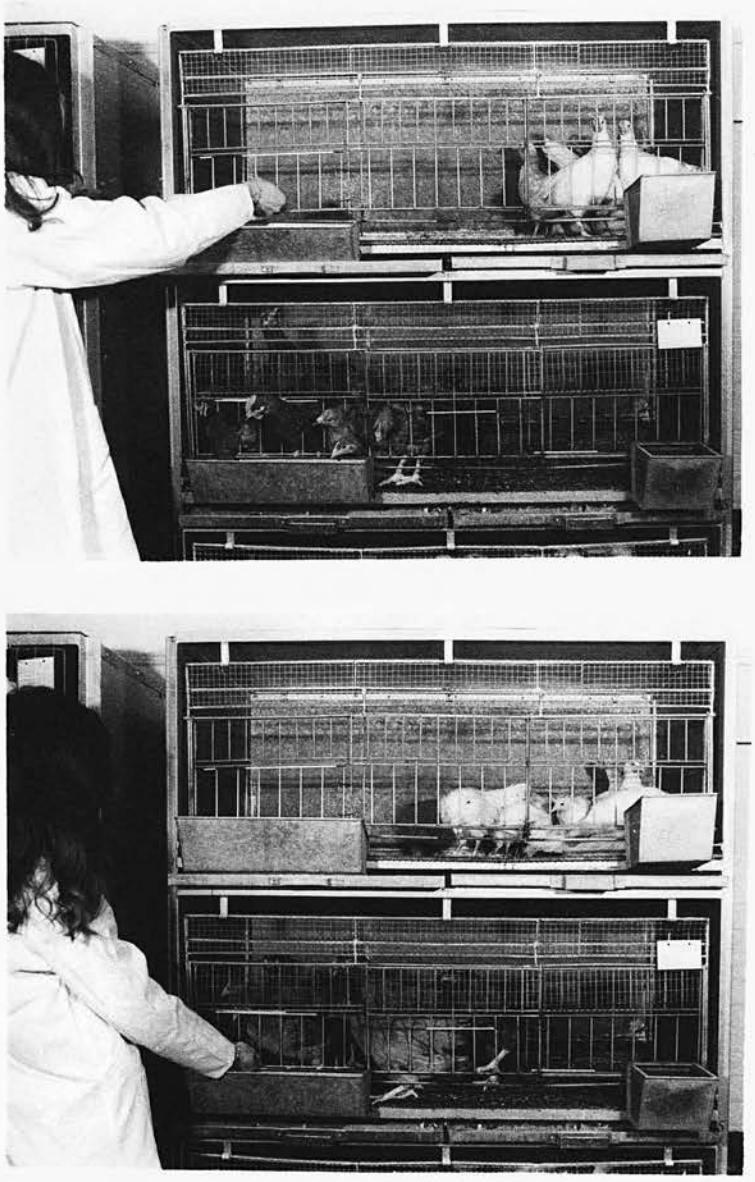
The most extreme withdrawal response, panic, was shown by fifteen white-stock birds but only one brown-stock bird.

The data are shown in Table B 2 A.

c. Handling by human being All white-stock birds struggled and squawked when they were first grasped; three brown-stock birds struggled and twelve clucked at this time. All birds of both stocks became quiet and motionless as soon as they were lifted clear of the cage floor.

Plate 4

Typical responses of 10-week old birds of the two stocks when a person stood in front of the home communal rearing cages.



In the upper-tier cage white-stock birds huddle at the side of the cage furthest from the person, even when offered food. In the lower-tier cage brown-stock birds approach the person, whether or not they are offered food.

Experiment B 2

Object To compare the responses of 10-week old, caged birds of both stocks to the same three stimuli as described in the previous experiment.

Materials and Methods Sixteen birds of each stock were observed. Experimental procedure was exactly as described for experiment B 1 with the following exception. The birds were transferred for observation from the rearing cage to an adjacent block of individual solid-sided cages each measuring 46 by 60 by 53 cm high.

Results

a. Presence of stationary human being Birds of the white stock showed significantly more withdrawal, mean score = 1.6 ± 0.2 than those of the brown stock, mean score = 4.4 ± 0.2 ($p < 0.002$, Mann-Whitney U-test, 2-tailed). Active withdrawal was shown only by white-stock birds and active approach only by those of the brown stock - see Table B 1 A. Typical responses of 10-week old birds in the communal rearing cages to the presence of a human being are shown in Plate 4.

b. Approach of human being As with the older birds, those of 10 weeks of age showed a large stock difference in their responses to the approaching human being. All of the white stock birds showed active withdrawal, the mean score being 1.3 ± 0.2, while most of the birds of the brown stock tended to remain still, with a few either approaching or withdrawing. Their mean score was 4.1 ± 0.5 and the scores were significantly higher than those of the white stock ($p < 0.002$, Mann-Whitney U-test, 2-tailed.)
The data are shown in Table B 2 A.

c. Handling by human being While they were being grasped fifteen

birds of the white stock struggled and fourteen squawked; amongst the brown stock none of the birds struggled but ten clucked. All birds of both stocks became quiet and motionless as soon as they were lifted clear of the cage floor.

Discussion of experiments B 1 and B 2

The stock differences in responses to human beings was obviously well established as early as 10 weeks of age. It was of interest that at both 10 and 16 weeks of age birds of both stocks showed some responses that differed from those shown by mature birds of their own stock. In the white stock the most common response to human approach shown by both 10- and 16-week old birds was panic. However this very intense withdrawal response was comparatively rare in mature white-stock birds. The younger birds of the brown stock, although not showing more intense withdrawal than mature birds of their own stock, did show active approach less frequently than the mature birds. However in both stocks many factors other than age *per se* may have contributed towards these differences including the recent handling or change of environment experienced by the younger, but not by the mature birds; some habituation in response on the part of the mature birds; stage of sexual maturity of the birds; or ratio of bird size to cage size. The following experiments examined the role of some of these factors.

The responses of younger birds of both stocks to being handled was virtually identical to that of mature birds of the same stock; but responses to human presence and approach differed with age. If anticipation of being handled was influencing responses to human approach then one might expect that the birds' responses to approach and handling would vary together with age. The fact that they did not do so

provided further evidence for the theory that anticipation of handling was not influencing responses to human approach.

Experiments B 3 and B 4

Introduction The preceding experiments established the following facts:-

1. In the presence of either a stationary or an approaching human being, white-stock birds of 10 weeks of age and older showed withdrawal responses of a significantly greater intensity, such as running to the back of the cage than those shown, if any, by brown-stock birds.

2. In both stocks the younger birds showed more withdrawal and/or less approach than mature birds of the same stock.

It was suggested (page 29) that anticipation of being handled did not influence the birds' responses to an approaching human being but that anticipation of being approached did perhaps influence their responses to a stationary human being. In Experiments B 3 and B 4 mature and younger birds were presented with a novel stationary or a novel approaching stimulus, neither of which involved the presence of a human being. If approach alone, without anticipation of being handled, was a sufficient stimulus to cause withdrawal responses then such responses should be shown to the novel approaching stimulus but not necessarily to the novel stationary one. Further, one reason suggested for the age-related differences in responses to approaching human beings which were found in both stocks, was that mature birds had to some extent habituated to this stimulus. If however, the same age-related differences were shown to a novel approaching stimulus the possibility of habituation to human approach could be excluded and some other stimulus-independent factors for the age differences sought.

It was obviously desirable that the two novel stimuli used should differ only in the respect that one should approach the birds and the other not. This however proved impossible to achieve for the following reasons:-

1. The novel stationary object had to be small enough to place in a bird's food trough so that neighbouring birds could not see it. (Numbers did not permit that only alternate birds be used). Also it had to be heavy enough that the birds could not dislodge it and large enough to ensure that the birds would notice it.

2. In order that the approaching stimulus could be moved through a standard distance towards the birds, only those housed in cages could be used. To avoid upsetting the birds, perhaps unequally in the two stocks, by transferring them for observation to an isolated cage they had to remain in their home cages.

3. The novel approaching object had to be small enough to be used inside a bird's cage (if it approached from outside all the birds in the unit would see it) and yet large enough to ensure that the birds would see it (in which case it was unavoidable that neighbouring birds would see it). The only suitable stimulus here was a balloon which could be passed through the cage bars and then inflated and in this way approach the birds.

But obviously a balloon did not satisfy any of the conditions required for the stationary novel object. The most suitable alternative that could be found which at least matched the inflated balloon in size and partly in shape (being three-dimensional) and colour was a child's plastic windmill.

Experiment B 3

Object To determine the responses of mature and 16-week old birds of both stocks to a novel, stationary object.

Materials and Methods Nine laying birds of each stock were observed at 8 months of age and sixteen birds of each stock at 16 weeks of age. All were housed in the battery unit. The birds ate from individual food dishes slotted into a trough which ran along outside the front of the cage. Each bird's cage front was 28 cm wide and the food dish was 14 cm wide. The novel object presented to the bird was a child's multi-coloured plastic windmill 13 cm in diameter. It was placed inside a food dish, the sides of which were sufficiently high to hide the windmill from birds in adjacent cages.

Experimental procedure was as follows. The observer stood behind the wire mesh wall of a pen 1.5 m across from the front of the battery unit. An assistant quietly moved along in front of the unit, below the level of the food trough and thus hidden from the birds. When three adjacent birds were all standing facing out of the front of their cages the experimenter gave a signal and the assistant slowly edged a windmill over into the food dish of each bird. It was possible to do this without the birds seeing the assistant's hands and without the windmill approaching the birds.

The birds were observed for a period of 5min and their activities towards the windmills recorded and classified as follows:-
Fixates windmill. Staring at windmill, with neck outstretched.
Pecks windmill. Each individual peck was counted.
Head out-in at windmill. A bird put its head out between the front bars of the cage above the windmill and then withdrew it again, without fixating the windmill.

Plate 5

Some of the behaviour patterns shown by mature birds when a novel object (windmill) was placed in the food dish outside the home battery cage.

The bird on the left has attempted to pull the windmill inside its cage and is now fixating the windmill. The bird on the right is pecking the windmill.

Peck-pull windmill. A bird pecked the windmill, grasped it in its beak and attempted to pull it into the cage. The bars of the cage and the rim of the trough prevented that from occurring.
Plate 5 illustrates some of these behaviour patterns.
Activities not directed at the windmill, such as preening or drinking, were also recorded.

Results With one single exception none of the birds showed withdrawal responses to the stationary novel object. In fact the windmill evoked a mild degree of exploration in many of the birds whilst others glanced at it briefly and then ignored it. There were neither age nor stock-related differences in the responses shown. Amongst the mature birds, six white-stock and four brown-stock birds fixated the windmill; one brown-stock bird pecked at it for a period of more than 5s whilst three white-stock and four brown-stock birds pecked at it in bouts of less than 5s duration. One white-stock and two brown-stock birds "peck-pulled" at the windmill. Amongst the 16-week old birds, seven white-stock and six brown-stock birds fixated the windmill; one brown-stock bird pecked at it for a period of more than 5s whilst five white-stock and four brown-stock birds pecked at it in bouts of less than 5s duration.
The data are shown in Table B 3 A.

Experiment B 4

Object To determine the responses of mature and of 16-week old birds of both stocks to a novel approaching object.

Materials and Methods In each stock eighteen laying birds of 9 months of age and sixteen 16-week old birds were observed; all were housed in the battery unit. (N.B. These were not the same birds as were used in experiment B 3.) The novel approaching stimulus used was an inflating red balloon attached to the end of a length of rubber tubing.

Experimental procedure was as in experiment B 3 except that now the assistant passed the balloon up through the floor at the front of the cage, inflated it to a diameter of approximately 15 cm and then allowed it to deflate. A balloon pump was used to standardise the amount and speed of inflation. Only birds which had been standing at the back of the cage facing the front were chosen for observation and only one bird was observed at any one time. Since the novelty of the stimulus was of prime importance in these observations, adjacent birds were never both used in this experiment. A maximum of two birds of each stock was observed in any one day.
The responses to the stimulus were scored as in experiment A 2 with score 1 representing maximum withdrawal and score 7 maximum approach.

Results

a. Mature birds There was a marked stock difference in the responses shown. All the white-stock birds withdrew from the balloon, either panicking or jumping at the back of the cage. Such extreme responses were shown only by eight of the eighteen brown-stock birds, while two actually approached the inflating balloon. The scores of the brown-stock birds were significantly higher than those of the white-stock birds. The data are shown in Table B 4 A.

b. 16-week old birds There was no significant stock difference in the responses of these birds to the inflating balloon. All of them withdrew to some extent: fifteen white-stock and eleven brown-stock birds panicked; one white-stock and four brown-stock birds turned and jumped up at the back of their cages; and one brown-stock bird backed away.

Discussion of experiments B 3 and B 4

Birds of both stocks and ages showed intense withdrawal responses to the approaching novel stimulus. This demonstrated that prior association of an approaching stimulus with subsequent handling was not essential in the elicitation of withdrawal responses and lends support to the theory, proposed in the discussion of Section A, that anticipation of being handled was not influencing the responses which birds gave to approaching human beings.

No birds of either stock or age showed intense withdrawal responses to the novel stationary stimulus (windmill). Although a major difference between this stimulus and the inflating balloon was that one moved towards the birds while the other did not, this was not the only difference. It was therefore not possible to definitely conclude that "approach" was the sole stimulus property of the balloon eliciting withdrawal. "Approach" is a complex stimulus for it involves the movement of the stimulus towards the subject; the consequent lessening of the distance between the stimulus and the subject possibly until the subject's flight distance is reached; and the apparent increase in size of the stimulus as it gets closer to the subject. Further, Guiton and Sluckin (1969) believe that, at least for young chicks, approaches from above and approaches from in front may not be equivalent stimuli. It was not possible to determine from

the present experiment the relative importance of these aspects in causing withdrawal from the inflating balloon.

How did the age differences in responses to the novel approaching object compare with those to the familiar stimulus of human approach? In the white-stock birds of both 16 weeks of age and as mature birds, the almost universal response shown to the novel inflating balloon was panic. Although this was also true of the responses of the 16-week old birds to human approach, only four of the twenty-four mature birds responded in this way. It therefore appears that the white-stock birds had to some extent habituated in their responses to the stimulus of human approach.

Amongst the brown-stock birds, all of 16 weeks of age withdrew from the inflating balloon, eleven of these panicking; ten out of eighteen mature birds withdrew from the balloon, only two of these panicking. In response to human approach, at 16 weeks of age four out of sixteen birds withdrew, including two which panicked; in the mature birds nine out of twenty-four withdrew but with no responses as intense as either panicking or jumping up at the back of the cage. These results are not as easily explained as were those of the white-stock birds. One possibility is that mature brown-stock birds had generalised their habituation of responses to include all approaching stimuli. Another explanation is that the red balloon aroused more aggression in mature brown-stock birds than in those of the white stock and that this aggression successfully competed with withdrawal tendencies. However previous incidental observations, verified in experiments C 11 and C 12, provided strong evidence that the colour red did not evoke different degrees of aggression in birds of the two stocks.

Experiment B 5

Introduction The preceding experiments have established the following:-

1. At 16 weeks of age birds of both stocks responded to an approaching, novel stimulus with intense withdrawal.

2. At around 8 months of age white-stock birds were also responding with intense withdrawal but brown-stock birds withdrew less intensely, if at all.

The present experiment determined the age at which, and intensity with which, such withdrawal responses first appeared in chicks of the two stocks. However before proceeding to describe this experiment it is relevant to review the extensive literature concerning the development of withdrawal responses in precocial chicks.

The development of withdrawal responses in precocial chicks - Literature Review

Introduction

The majority of bird species have, as their sole defence against predators, a capacity for rapid escape or withdrawal. Defence by attack is less common and a characteristic response of flocks of birds rather than individuals. Amongst those species which have secondarily lost the use of flight, defence takes the form of extreme alertness to environmental stimuli coupled with the ability to flee rapidly to cover across the ground or to jump upwards into trees. Chicks of precocial bird species also rely on such measures to escape predation and the development after hatching of escape responses in these chicks has been widely studied.

There is some disagreement in the literature as regards the exact age after hatching at which the responses first appear. This variation however is entirely accounted for in terms of the different

species and breeds observed, the different stimulus situations which have been used to elicit the responses and the differences in the nature of the responses which various authors have classified as constituting escape or withdrawal. Some confusion of terminology also exists in this sphere. Although it is obviously the same phenomenon which is being described in all cases, the response pattern has been variously named as follows:- aversive responses (Guiton and Sluckin 1969); escape and avoidance responses which form part of "fear" (Phillips and Siegel 1966); escape responses including running and freezing (Kruijt 1964); "active fear responses" including withdrawal, avoidance, searching and escape (Salzen 1962); avoidance responses including withdrawal and crouching (Schaller and Emlen 1962); fear responses (Gray and Howard 1957); emotional responses (Hess 1957); and fear reactions or flight responses used interchangeably (Jaynes 1957). The name used perhaps reflects the main interest of the author and whether he was concerned (a) with the stimulus situation eliciting the response in which case he may have chosen the term "fear response" or "emotional response" or (b) with the response itself thus choosing "withdrawal responses", "avoidance responses" or "freezing"; or (c) with the function of the responses, in which case the term "escape responses" would most likely have been used.

The stimulus situations eliciting the responses will be first examined and then the nature of the responses elicited. The nomenclature used by each individual author to describe stimulus properties or response patterns will be adhered to and for the purpose of this review section the terms "fear", "avoidance", "withdrawal" and "escape" should be regarded as interchangeable at a general level.

Stimulus situations

Kruijt (1964) reported that in Jungle Fowl chicks, escape responses might be elicited by tactile stimuli such as being stood on by another chick or suddenly seized by a human being; by auditory stimuli an example being hand clapping; and by visual stimuli. He stated a belief that "novelty" and "intensity" were the fear-inducing properties of visual stimuli. Novelty was also described by Salzen (1962) as being the fundamental property of a fear-producing stimulus. He found that domestic chicks of all ages showed fear of a strange, static and inanimate environment, and this fear arose, he argued, because this environment differed from their familiar home environment. However only chicks with 24h experience of a particular moving object showed fear of strange, mobile and animate objects since only those chicks could perceive them as novel. Chicks with no previous experience of moving objects had no familiar object with which to compare the "strange one". They therefore did not perceive it as novel and were not afraid of it.

A similar theory regarding novelty as a major cause of fear was originally expounded by Hebb (1953) as follows, "fear originates in the disruption of temporally and spatially organised cerebral activities". This theory explained the absence of fear in neonates in terms of the absence of organised cerebral patterns of perception. Only once these had become established could the unfamiliar or novel be perceived as such, and feared. Strong confirming evidence for this theory came from the work of Moltz and Stettner (1961). They raised ducklings fitted with plastic hoods which admitted only diffuse (i.e. unpatterned) light and found that when the hoods were removed after up to 72h after hatching these birds showed significantly less avoidance in an imprinting situation than did normally reared conspecifics.

An alternative theory attempting to explain the initial absence and subsequent appearance of avoidance responses in newly hatched precocial birds was proposed by Hess (1959) and by Schaller and Emlen (1962), who claimed that the change is due to the maturation of the CNS and relatively independent of the birds' experiences. Schaller and Emlen reared White Leghorn x New Hampshire chicks in isolation and in complete darkness for 1, 2 or 3 days after hatching. Then, after a 10min period for light adaptation, the responses of these chicks to an approaching object were compared to those of chicks reared in light. Equally intense avoidance responses were shown by chicks of both groups, although according to Hebb's "novelty" theory they should have been absent in the chicks reared in the dark.

An explanation for this discrepancy with Hebb's theory was offered by Bronson (1968 a) who suggested that there are two sources of fear in visual stimuli. One source is their novelty and a stimulus cannot be feared in this respect until an individual has established what is familiar - in other words Hebb's theory. According to Bronson the hooded ducklings of Moltz and Stettner were not afraid of the novel environment of the imprinting runway because they had been unable to form a perceptual pattern of their home environment with which to compare the novel one. Bronson's second source of fear is objects which move towards an animal and this fear, he claimed, is independent of prior visual experience. This explained the equally intense responses of Schaller and Emlen's chicks to the approaching stimulus regardless of whether they were reared in the light or dark. Schiff, Caviness and Gibson (1962) described the optical stimulus arising from the approach of, or approach to, a body as "looming" and found it to be a very efficient releaser of avoidance responses in

rhesus monkeys and chicks (Schiff 1965). Avoidance responses were obtained by Melzack (1952) in a wide range of ages and breeds of dogs by opening an umbrella in front of them, an example of a "looming" stimulus.

While all the published studies to that date seemed to fit Bronson's (1968 a) two-part theory a later one appeared not to conform to it. In an experiment basically similar to that of Schaller and Emlen (Loc cit) a comparison of Cobb chicks reared either in the light or dark was made by Guiton and Sluckin (1969). Contrary to the findings of Schaller and Emlen they found stronger avoidance reactions to an approaching object in the chicks reared in the light than in those reared in the dark, when tested at 24h of age. Apart from the different breeds of chick used, there were several other differences between the two studies. Schaller and Emlen's chicks which were reared in the dark, were allowed a 10min period of adaptation to light before testing, their stimulus was introduced into the chicks' home boxes and approached the chicks in a plane parallel to the ground. Guiton and Sluckin's chicks were only allowed 5min light adaptation; were removed to a strange environment for testing and exposed to a stimulus approaching from above. Further, they replaced their chicks to the centre of the arena between trials, which of necessity must have involved approaching and handling them; Schaller and Emlen's chicks were not similarly disturbed between trials. The difference in techniques employed in these two studies and the different results which emerged from them clearly illustrates the complexity of this stimulus-response situation.

Response patterns

1. To auditory stimuli In Jungle Fowl chicks auditory stimulation elicits fast running followed by squatting and no calls are made (Kruijt 1964). This response appears on the first day after hatching and increases in intensity during the second and third days. After the fifth day a trill call may also sometimes be emitted in response to auditory stimulation. In domestic chicks of under 1 week of age Phillips and Siegel (1966) found the most clear-cut response to a sudden auditory stimulus (the ringing of an electric doorbell) to be an inhibition of peeping and other current activities. They also often observed running followed by crouching or freezing.

2. To visual stimuli Novel visual stimuli may be presented to an animal in two main ways. The animal may be transferred from its home environment to a strange one, the whole environment thus being the novel stimulus. However this generally involves changes not only of visual characters but also of auditory, tactile, thermal and social ones. A detailed survey of the responses occurring in this type of situation will be made in Section C. Alternatively, novel stimuli may be introduced into the animal's home environment and the responses shown by precocial chicks in such a situation vary with many factors, two of the main ones being the age and rearing history of the chicks:-

a. Age There is general agreement on the nature of the responses shown toward novel objects introduced into the home environment but much disagreement as to the age at which they appear. This seems very much to depend on the previous experience of the chicks and in particular whether they were reared as part of a social group or in isolation, and whether in the light or darkness. Kruijt (1964) reported that he was unable to elicit escape from such stimuli as waving a hand or a sheet of paper until the second day after hatching and then only slight

withdrawal occurred. More intense responses did not appear until the chicks were 1 week old. However as well as age itself, he found novelty to be an important factor in determining the strength of the escape response, since chicks not previously exposed to the Experimenter showed strong escape as early as 3-4 days. Kruijt stated that vocalisations are almost always given in response to alarming visual stimulation - the reverse being true of auditory stimulation.

Phillips and Siegel (1966) using a hand thrust as a stimulus found little response in newly-hatched White Plymouth Rock chicks, but by 24h crouching or running were fairly common and by 48h nearly all chicks were responding in this way. Thirty hours was the earliest at which Jaynes (1957) obtained flight responses in New Hampshire Red chicks reared in groups to a moving green cardboard cube. The intensity of response increased during the first week of life and then began to decrease.

Hess (1957) reported that mallard ducklings first showed avoidance of moving objects at 20h, with 80% of subjects avoiding by 24h and 100% at about 32h. Fear responses in Indian River chicks were found to be at maximum sometime between the 3rd and 5th day, thereafter declining (Gray and Howard 1957). While some domestic chicks showed avoidance responses as early as 5h after hatching others did not do so until 30h; there was a peak in response intensity at 50-80h declining to a stable level at 100h (Schaller and Emlen 1962).

b. Rearing history Salzen (1962) demonstrated the effects of rearing conditions on the development of fear responses towards moving stimuli in Brown Leghorn x Light Sussex chicks. Chicks reared in groups showed fear responses after 24h of age but those reared in isolation and first exposed to a moving, though not approaching, stimulus at 7 days

old showed, after an initial fear reaction, pleasure responses to the stimulus. Salzen described various categories of "active fear" which his chicks showed towards the stimulus - withdrawal, avoidance, searching and escape - and he also listed as responses "passive fear" which involved standing still and peeping or "freezing", described as crouching low and silently. These different types of response, he said, did not imply different grades of fear but rather which one was shown by a particular chick depended "on the degree of localisation of the fear-arousing stimulus and the bird's previous experience of it". Strange moving objects, according to Salzen, resulted in flight/avoidance which may or may not be accompanied by distress calls.

Schaller and Emlen's (1962) study remains one of the most comprehensive regarding the development of avoidance responses to moving objects in precocial chicks. As well as chicks of seven different breeds of domestic fowl they observed those of nine other species including turkeys, pheasant, quail and waterfowl. The stimuli used were cardboard rectangles of various sizes and colours, a live white rat, a live adult fowl and a stuffed owl. All chicks were presented with the stimulus in their home environment. The authors found avoidance responses to be of two main types - evasive withdrawal accompanied by vocalisation or an essentially silent and motionless crouch; the latter being more common in wild than domestic species. Schaller and Emlen graded the withdrawal responses shown according to their intensity and found, that in all the species and breeds observed, maximum intensity of withdrawal was shown between 100 and 140h, with the lowest intensity of response appearing by 10h. There were breed and species differences both in the shape of the curve of response-intensity increase with increasing age, and in the ultimate intensity of response reached, this being higher in wild than domestic species. Allowing for

differences in species and in experimental design the results of these observations were unanimous with those of others in their finding that responses of a withdrawing or avoiding nature given to certain classes of visual stimuli appear very shortly after hatching in precocial birds and thereafter increase in intensity during approximately the first week of life.

Experiment B 5

Introduction and Object While the majority of studies described above stated the age at which the withdrawal responses of chicks were of maximum intensity few followed through the exact level to which they then declined or indeed at which age the decline ceased. Gray and Howard (1957) stated that withdrawal responses would never completely disappear in the wild. This is obviously true, for while the rapid development of withdrawal responses to environmental stimuli are essential to the survival of a newly-hatched chick in the wild, their maintenance as the bird grows older is equally important with habituation of response to harmless stimuli probably occurring. The withdrawal responses to human beings or to an inflating balloon shown by birds of 10 weeks of age and older in the present study, were certainly the same behaviour patterns as those described in the literature as developing in chicks during the first week after hatching. In most of the age-stimulus combinations observed the white-stock birds showed withdrawal responses of a greater intensity than those of the brown-stock birds. Further, in mature birds of both stocks the withdrawal responses to human beings appeared to have somewhat habituated.

The present experiment compares the intensity of withdrawal responses to a novel approaching stimulus shown by chicks of the two stocks at 4 days or 1 day after hatching.

Materials and Methods Thirty different chicks of each stock were observed at each of approximately 110h (4 days) and 30h (1 day) after hatching. Eight hours after hatching they were placed individually in standard chick-boxes, this was done in the dark so that the chicks would not see the experimenter. Doors had been cut out in the sides of the boxes through which the food and water jars were removed for filling without the experimenter's hand being visible to the chicks. The boxes were kept in a screened-off pen and the heat lamps did not cast shadows, thus with the exception of their own body parts the chicks were deprived of moving stimuli.

Experimental procedure was as follows - When a chick was observed to be standing in the centre of its box facing the front and not engaged in any obvious activity the experimenter slowly placed her hand over the top of the box and approached the chick at an angle of approximately 45° with fingers outstretched. The chick's response to the approach was noted. Responses were scored along a scale in which score 1 represented maximum withdrawal from the approaching stimulus and score 6 maximum approach. These were:-

1. Panic (undirected running or flying around box, frequently hitting the walls and accompanied by loud fear trills).
2. Ran around box.
3. Took one or two steps backwards.
4. Stood still, staring at approaching hand.
5. Showed "intention movements to attack hand" i.e. stretched whole body upwards towards hand, raised wings and paced on the spot.
6. Attacked hand. As for 5 but followed by jumping up at hand usually pecking it.

Results

a. 4-day old chicks Half the chicks of both stocks showed an intermediate response, either standing still or taking a few steps backwards. Whereas all fifteen remaining white-stock chicks showed more intense withdrawal than this, only nine of the brown-stock chicks did so and the other six actively moved towards the approaching stimulus. The mean $\pm$ SE score of the white-stock chicks was 2.7 ± 0.2 and that of the brown-stock chicks, 3.6 ± 0.3 ($p < 0.02$, Mann-Whitney U-test, 2-tailed).

The data are shown in Table B 5 A.

b. One-day old chicks Chicks of both stocks tended towards higher scores, less intense withdrawal, than those of the 4-day old chicks though the stock difference was maintained. No chicks panicked and there were more cases of active approach in both stocks. The mean $\pm$ SE scores were 3.5 ± 0.2 for the white stock and 4.3 ± 0.2 for the brown stock ($p < 0.02$, Mann-Whitney U-test, 2-tailed).

The data are shown in Table B 5 A.

Experiment B 6

Introduction and Object The preceding experiment showed withdrawal responses to a novel, approaching stimulus to be fairly well developed in chicks of both stocks as early as 30h after hatching. The present experiment examined the responses of even younger chicks, approximately 12h after hatching. To verify that the response is, as suggested by the literature, an innate one, stringent precautions were again taken to ensure that the chicks were not previously exposed to any moving stimulus whether approaching or otherwise.

Materials and Methods Thirty chicks of each stock were observed. They were hatched in individual cardboard boxes measuring 76 by 76 by 63 mm, incubation and hatching being carried out in the dark. Ten hours after hatching each box was transferred to a standard chick-box where it was left unopened for 2h. This allowed the chicks some adaption to light, which passed through the perforations in the boxes and also some adaptation to the different environmental noises. After this time each chick was gently emptied out of its hatching box in darkness and after a further 10min for light adaptation was subjected to an approaching hand as described in the previous experiment.

Results Only two types of response to the approaching hand were observed. Chicks either stood still or they attempted to withdraw from the hand, although their limited locomotor ability generally rendered these attempts unsuccessful and no grading of withdrawal responses was possible. No attempts by the chicks to approach the hand were seen. There was however a significant stock difference in the proportions of chicks showing the other two responses, for while nineteen out of thirty white-stock chicks withdrew, only nine brown-stock chicks did so ($\chi^2 = 5.42$, $p < 0.02$).

Discussion of experiments B 5 and B 6

The results of these experiments agreed with those cited in the literature review that the intensity of withdrawal responses to a novel approaching stimulus increases with age during the first week after hatching. This undoubtedly is related to the increasing locomotor ability of the chicks which develops during this time.

The results also demonstrated very clearly that as early as 12h after hatching (in terms of numbers of chicks) and still at 110h after hatching (in terms of intensity of withdrawal) the white-stock chicks were showing more withdrawal than the brown-stock chicks. These findings suggest a genetic basis for the stock differences in withdrawal responses found amongst older birds in the preceding experiments. Similar differences between various strains of domestic fowl were reported by Phillips and Siegel (1966).

Conclusions from sections A and B

Briefly summarizing some of the experimental facts which have been established it has been found that:-

a. In response to a novel and approaching stimulus

At 12h, 30h, 110h) white-stock chicks withdrew more than brown-stock chicks.

At 16 weeks - birds of both stocks withdrew equally.

At 8 months - white-stock birds withdrew more than brown-stock birds.

b. in response to the familiar stimulus of an approaching human being

At 8 months, 16 weeks, 10 weeks) White-stock birds showed more withdrawal than brown-stock birds.

Of the two stocks the behaviour of the white birds was certainly more stable. As soon as they were physically able, they responded with a high intensity of withdrawal to a variety of stimuli and throughout life continued to do so. Indeed casual observation on birds of 3 years of age showed that the withdrawal response to human beings was

almost as intense as in younger birds. But amongst the brown-stock birds there were greater changes in the incidence and intensity of withdrawal responses. For instance 16-week old birds showed very intense withdrawal to a novel and approaching stimulus but mature birds showed hardly any.

It is impossible to determine the exact stimulus factors causing withdrawal responses. If the stimulus was a novel one, "approach" appeared to be more effective then "no-approach" although since other variables were involved in this experiment this can only be a tentative conclusion. The situation regarding novel stimuli is obviously complex, as the stock and age of the birds were also involved in determining the intensity of withdrawal shown. If the stimulus was familiar, as a human being, approach was not necessary to elicit withdrawal although it was possible that the birds associated stationary human beings with ones about to approach. Again age and more especially stock of bird played a role in determining the intensity of withdrawal. Inextricably confounded with "approach" is flight distance and this also is a complex factor. Actual distance between stimulus and bird cannot be the only effective variable involved, since for instance birds did not withdraw from a novel, stationary object (windmill) placed in the food trough adjoining their cages but they did withdraw from a stationary human being some distance away.

Thus withdrawal responses in domestic fowl are a complex phenomenon and it is not possible to define in a simple manner the stimuli which will evoke them. In the literature review given earlier in this section it was noted that withdrawal or escape responses were usually classified under the general title of "fear behaviour" and that other types of response as well as withdrawal, for instance freezing, was also classified as fearful. "Fear" is the subject of the next section of this study and the two stocks are compared in a variety of "fearful" situations.

In view of the relative stability of the flighty, withdrawal response in the white stock birds they will from now on be referred to as the flighty-stock birds. The brown-stock birds, characterised by their lack of flightiness towards human beings will be referred to as the docile-stock birds. This renaming was done as a constant reminder in later experiments of the direction of this difference between the two stocks.

SECTION C

"FEAR" - A LITERATURE REVIEW

1. Introduction

The single word "fear" is undoubtedly one of the vaguest in use in the ethological and psychological literature. There is, as yet, no universally accepted definition of the word although most people would claim to know what it means. The cause of much confusion is probably the fact that the one word "fear" is used to decribe stimuli, responses and an underlying motivational state. The terms fear-producing stimuli, fear responses and being in a state of fear are commonly used; whereas in another system the equivalent terms would be food, eating and being in a state of hunger. It is not always immediately obvious in which of the above three contexts the word "fear" has been used by a particular author. In the present study, unless quoting, the word fear will be used to represent an underlying motivational state; fear stimuli and fear responses will be referred to as such. The general term "fear system" will be used to embrace all three meanings when it is wished to make broad comparisons with other systems such as the feeding system or aggression system; the convenience of such general terms has been referred to by McFarland and Sibly (1972).

As Gray (1971) pointed out we would not need to use the expressions "fear stimuli" and "fear responses" if, as is the case in most other behaviour systems, the stimuli involved were small in number and there was a single consummatory response. But the difficulty of formulating suitable definitions is greatly increased by the sheer number and variety of stimuli and responses involved in the fear system and their variation with such factors as species, strain, individual, sex, age, previous experience and prevailing environmental conditions.

2. Fear stimuli

It is often not intuitively obvious whether a particular stimulus will elicit an observable fear response although in other systems such as feeding, sex and aggression a fairly accurate prediction can usually be made. A fear stimulus is thus frequently only labelled as such after it has been shown to elicit a response classified as fearful. Some degree of classification of fear stimuli is however possible and much early work concentrated on the determination of stimuli which would, on first presentation, evoke fear responses in animals and in human beings. Valentine (1930) cited a range of stimuli, noises, dogs, the sea and the dark, which evoked fear in young children; dogs were afraid of a masked person, a horse skin, a mechanical turtle, a toy car and an umbrella (Melzack 1952); and chimpanzees showed fear of skulls, a rubber dog, snakes and an anaesthetised chimpanzee (Hebb 1953). It is clear from this type of study that the higher up the evolutionary scale a species was, the greater the list of fear-provoking stimuli and also the greater the variability between individuals in their susceptibility to them (Hebb 1966).

No single property has been found to be characteristic of all fear-producing stimuli. Hebb (1953) proposed three main sources of fear:-

1. Conflict. This includes fears induced by pain, loud noise, dead or mutilated bodies, and strange persons or animals.
2. Sensory deficit. The fear caused by loss of support, by darkness or solitude.
3. Constitutional disturbances and maturation. An example being the shyness typical of adolescents.

Gray's (1971) classification of fear stimuli has four main sub-divisions:-

1. Intensity. This includes suddenness of presentation and examples are

pain, loud noise, bright lights, electric shocks and sudden unexpected movement.

2. Novelty. As well as more obvious examples Gray proposed that a "lack of stimulation" was novel and thus explained animals' fear of solitude or of dead bodies.

3. "Special evolutionary dangers". This too might explain fear of dead bodies and Gray believed such dangers to account for fear of the dark , of snakes and possibly of heights.

4. Stimuli arising from social interactions. Fear of dominant conspecifics falls under this heading.

Any stimulus not falling into one of the above categories may come to elicit fear through the process of conditioning (Miller 1948, Brown and Jacobs 1949).

Novelty is undoubtedly the stimulus characteristic most often associated with fear and those attempting concise definitions within the fear system generally do so in terms of novelty. King (1966) stated that "stimuli that elicit fear must be described in terms of novelty" and also suggested that the more novel a stimulus was the greater the fear it would induce. Bronson (1968b) identified fear as "an aversive reaction to novel visual patterns".

3. Fear responses

a. The recognition of fear responses Fear responses may be observed and measured at either a physiological or a behavioural level. Physiological responses are under the control of the autonomic nervous system and include changes in the gastro-intestinal and urinary tracts, changes in the circulatory and respiratory systems, and pilo-erection of hairs or feathers. But similar responses also occur during other motivational states, such as aggression, and it is often difficult to tell which state has caused a response such as increased heart rate (Morgan 1965); although in such cases the animal's behaviour will usually

indicate its underlying motivation. On the other hand it may not always be obvious from an animal's external appearance that it is in a state of fear. For instance, if an animal is suddenly placed in a strange environment it is perhaps reasonable to presume it will be afraid. But if it lies down and appears to go to sleep does this mean it is not afraid, only tired? In a case such as this in which the animal's behaviour is difficult to interpret, a physiological measurement, for instance heart rate or skin temperature, would be a valuable aid in determining its motivational state. Ideally both physiological and behavioural measurements are desirable but unfortunately it is rarely practicable to obtain reliable physiological measures. In this study measurements of fear will be confined to those observable at a behavioural level.

b. Some definitions of fear responses Behavioural responses to fear have frequently been defined in general terms as avoidance or withdrawal actions (e.g. Hebb 1953, Hinde 1970). Withdrawal of course does not necessarily imply fear, for the source of this response may be a bad smell rather than a large dog or a spider. Freezing has also been regarded as indicative of fear (Andrew 1956a, Hinde 1970). Indeed freezing or crouching have sometimes been credited as arising from higher degrees of fear than more active responses (Arnold 1945, Miller 1948). Others maintained that the two types of response do not vary with the intensity of the stimulus but rather according to whether it is diffuse or discreet in its localisation (Andrew 1956 a, Blanchard and Blanchard 1969). If an animal indicated by "associated signs" that it was about to show avoidance of a stimulus then this too might be regarded as a fear response (Hebb 1953).

c. The ranking of fear responses Some authors have ranked the fear responses shown to a given stimulus in order of their supposed intensity of fearfulness. Responses shown by dogs to a wide variety of novel

objects were ranked by Melzack (1952) as orientating the head at right angles to the object (minimal fear), through crouching with ears pressed down (intermediate fear), to running as far away as possible (maximal fear). Rats were rated along a four-point scale for their behaviour in such situations as being captured in the home environment, being handled and being prodded with a pair of forceps. The responses of tame albino rats were used as the zero point in the rating scale (Brady and Nauta 1953).

Three grades of fear in juvenile domestic fowls were recognised by Wood-Gush and Guiton (1967). These were: extreme fear, including both freezing and flying around the cage; moderate fear, which involved visually exploring the environment; and slight fear, which was visual exploration and also pecking at the stimulus objects.

A common factor in each of these studies was that no objective basis was used in ranking the responses. In the fear system this is a problem which is generally unavoidable and it is encountered in the experimental part of this section.

d. Factors affecting the type and intensity of fear response shown

1. The fear stimulus. Animals in the wild show different fear responses to aerial and to ground predators (Hediger 1950, Tinbergen 1957).

2. The presence of conflicting motivational states. Fear responses nearly always take precedence over those of other systems such as feeding and sex (Hediger 1955, Andrew 1956b).

3. The species or breed of animal. Working dogs, bred for intelligence, are more susceptible to fear than bulldogs or terriers, bred for pugnacity (Mahut, in Hebb 1966).

4. Age of animal. Adult chimpanzees were terrified of objects which infants ignored (Hebb 1966).

5. The environmental conditions in which the fear stimulus is presented. Birds reared in groups were less afraid of visual novelty if a companion bird was present (Salzen 1962) and novel objects were responded to differently according to whether they were presented in the home or in a strange environment. (Bronson 1968 a).

4. Defaecation as a fearful response - the Open Field Test

A well recognised response in a fearful situation is loss of control over the bowel or bladder. Yoshioka (1932) observed that this response was common in rats when placed in a strange enclosure. Hall (1934 a) found that such defaecation and urination gradually ceased to occur if rats were repeatedly (2min every day) placed in the strange enclosure. Hall (1934 b) adopted the term "emotional defaecation" for the response and defined it as "that which gradually ceases upon repeated experience with the situation which originally evoked it". Emotionality Hall (1934b) defined as "The state of being emotional. This state consists of organic, experimental, and expressive reactions and denotes a general upset or excited condition of the animal". Following his finding that there was a close negative correlation between the number of days during which a hungry rat defaecated in a strange place and the number of days it abstained from eating in that place, Hall (1934 b) claimed that the emotional defaecation response could validly be used as a measure of individual differences in emotionality. He assumed a priori that "the greater the number of trials a rat required before food was eaten could be taken as a measure of the rat's emotionality". This assumption appears to have gone unchallenged.

Hall described the type of enclosure he used to elicit defaecation in his rats as an "Open Field" and it is typically a brightly-lit, circular or, less commonly, square arena, completely devoid of furnishings. Measuring the "emotional defaecation" of a rat placed in such an enclosure has become known as "Hall's Open Field Test of Emotionality". Indeed it is almost the only situation used to study innate fear in rodents; any publication with the word "fear" in the title is almost guaranteed to contain the words "Open Field" in the Materials and Methods section. Hall (1941) said he now felt the term "emotionality" to be too inconclusive in describing the trait measured and proposed that "timidity" should be used instead, although other words such as fearfulness, wildness, nervousness, agitation, excitability and instability might be used interchangeably. However by then "emotionality" had become and still generally is, the word used to describe the trait measured by defaecation in the Open Field; a trait which some present-day authors have taken to mean "fear of novel stimuli" (King and Appelbaum 1973).

In assuming that he had measured individual differences in a behavioural trait and not just in one response to one stimulus Hall started a controversy which was disputed by dozens of laboratories. Attempts were made to support Hall's theory by showing that (a) manipulation of factors which could be assumed to affect the level of fear of an individual in an Open Field did in fact affect the defaecation response in the predicted direction and that (b) there was positive correlation of defaecation in the Open Field with other supposed measures of emotionality or fearfulness in the rat. Thus the following experiments have been proposed as support for Hall's

theory:-

1. Anderson 1938. Those rats which had a high level of Open Field defaecation (measure was total number of boli in four, daily 3min tests) also showed the highest level of defaecation in a water-wading situation (measure was the total number of boli in sixteen, 3min tests) and they had the longest latencies to emerge from their home cages or from a stove pipe. Anderson suggested "timidity" a more accurate description of the trait thus measured.

2. Parker 1939. Open Field defaecation correlated positively in individual rats with defaecation in five other fearful situations including the sound of a buzzer, or during forced swimming.

3. Billingslea 1941. Rats with a high level of defaecation in the Open Field (measure was the number of days out of twelve during which an animal defaecated or urinated) also showed relatively longer latencies to emerge from the home cage, and were more timid in their responses towards the experimenter.

4. Broadhurst 1957. Defaecation in the Open Field increased (measure was the total number of boli and the number of days boli were emitted by an animal) as the intensity of light and sound to which the rat was exposed in the Field increased.

But there have also been many results published which have been proposed as refuting Hall's theory. They all found that individual differences in rats' emotionality as measured by the Open Field Test did <u>not</u> correlate with individual differences in other supposed measures of emotionality.

Some examples are:-

1. O'Kelly 1940. No relationship was found between Open Field defaecation (measure was whether or not the rat defaecated) and

performance in a water-wading maze (measure was the number of trials to reach criterion and the average number of errors).

2. Bindra and Thompson 1953. No significant relationship was found between defaecation in the Open Field (measure was the number of days out of ten during which a rat defaecated or urinated) and the latency to emerge from the home cage and reach food at the end of a runway. They proposed that what defaecation in an Open Field indicated was "autonomic reactivity" or "susceptibility to a very general type of emotional disturbance which leads to defaecation and urination under conditions of any unusual stimulation". This, they said, ought not to be equated with "fearfulness" or "timidity".

3. Hunt and Otis 1953. There was no correlation between an individual's Open Field defaecation (measure was the number of boli per minute) and its latency to leave the home cage to obtain food placed outside it.

4. Ader, Friedman and Grota 1967. Hooded and albino rats showed no differences in Open Field defaecation (measure was not stated) although they were known to be very different with regard to their reaction to handling.

Having read the foregoing evidence for and against Hall's theory it will come as no surprise that there has been so much disagreement, for no two experimenters mentioned measured Open Field defaecation in the same way. A similar situation occurred in those experiments which examined the effects on Open Field defaecation of such factors as age, sex and rearing experiences of the rat being tested. The results of some of these experiments are listed in Table C1. It must be emphasised that these represent only a very small part of a very

large literature but they illustrate well the number and variety of methods which have been used to measure this one response. If after 30 years and hundreds of experiments it has not yet been decided how best to measure this one response to one stimulus in one species it is perhaps not so surprising that our knowledge of the fear system is so limited. A possible reason why no agreement on measurement has been reached is that, with a few notable exceptions such as Bruell (1969), the possible adaptive significance to rodents of defaecation in a strange environment has not been considered. Perhaps if this factor, rather than suitability to an automatic counting device, were considered then a suitable measure might be more logically chosen.

Despite the controversy surrounding the Open Field defaecation response it has been shown to have a heritable basis. Both Hall (1941) and Broadhurst (1961) have bred rats selected for either high or low scores; the techniques of cross-fostering at birth and of two-way reciprocal crosses proving conclusively the importance of genetic components in the separation of the mean scores of the two lines with succeeding generations.

Much space in this review has been devoted to the responses of rats placed in an Open Field situation. This is because the vast majority of publications relating to "fear" are restricted to, this area. The Open Field Test is so easy to carry out, requiring a minimum of space, materials, observations and analysis that its popularity is unsurpassed. And of course as an experimental animal few have seen beyond the highly inbred strains of domestic rat. Apart from rats and other rodents, the responses to a strange

Table C 1 (page 1)

A summary of some experiments which have used defaecation in an Open Field as a measure of rats' emotionality and the effects of different variables on this response.

AUTHOR	DATE	EXPERIMENTAL VARIABLE	MEASURE OF EMOTIONALITY	DIRECTION OF DIFFERENCE
Broadhurst	1958a	Age when first tested	Cumulative number of boli in 4, daily 2min tests	Strain X - no difference between 53 and 113 days Strain Y - higher score at 100 than at 240 days
Candland & Campbell	1962	Age when first tested	Number of boli in a 10min test	Zero at 18 days, increasing to 54 days and then stable to at least 200 days
Valle	1971	Age when first tested	Number of boli in a 5min test	More at 150 than at 50 days
Harrington	1972	Strain	Cumulative number of boli in 4, daily 4min tests	Different scores amongst 12 inbred strains
Broadhurst	1957	Sex of animal	Cumulative number of boli in 5, daily tests and the number of days on which each rat defaecated	Females had higher scores than males on both measures
Anderson	1938	Sex drive of males as measured by the number of completed matings during 6, 15min tests	Cumulative number of boli in 4, 3min tests at 4 day intervals	The higher the sex drive score the lower the emotionality score
Broadhurst	1957	Intensity of light or of white noise during test	Cumulative number of boli in 5, daily tests and the number of days on which each rat defaecated	The higher the intensity the higher the emotionality score
Anderson	1939	Presence or absence of second rat during test	Number and weight of boli	No differences

Table C 1 (page 2)

AUTHOR	DATE	EXPERIMENTAL VARIABLE	MEASURE OF EMOTIONALITY	DIRECTION OF DIFFERENCE
Goldman	1965	Shocking and/or handling during rearing	Cumulative number of boli in 2, daily 3min tests	Score was a curvilinear function of the amount of infant stress
Ader	1966	As above	Number of boli during a 2min test	No consistent pattern
Levine et al	1967	Handling during infancy	Number of boli in a 3min test	Handled subjects had lower scores than unhandled ones
Koch & Arnold	1972	Reared by mother or artificially	Percentage of animals urinating over 6 daily tests	Artificially reared animals had higher scores
Denenberg & Whimbey	1963	Whether mother was handled during her infancy	Cumulative number of boli in 4, daily 3min tests	Score was higher if mother had been handled
Joffe et al	1973	Whether able to control lighting, food etc during rearing	Cumulative number of boli in 4, daily 2min tests	Those able to control their environments had lower scores
Ader and Friedman	1964	Reared in groups or individually	Number of animals which defaecated during a 2min test	Group-reared animals had the higher scores
Gray et al	1965	Whether given a placebo injection at 5 days of age	Cumulative number of boli in 4, daily 2min tests	Those injected had the higher scores
Richam et al	1972	Whether the animal had been bulbectomised	Number of boli in a 10min test	Those operated upon had the higher scores

environment of only one other species - the domestic fowl - have been investigated to any great extent. But because of the technical difficulties of keeping adult birds, these investigations have nearly always used young chicks. Their findings are given below.

5. The behaviour of the domestic fowl in Open Field Tests

a. Defaecation and freezing Candland and Nagy (1969) observed White Leghorns of both sexes and of several different ages at first test ranging from 1 to 90 days in a 4 foot diameter Field with a wire mesh floor and black-painted walls. At all ages the mean number of Open Field defaecations was significantly higher than the corresponding number in the home cage. It was greater at 15 days of age than at 1 day and was thereafter stable. The percentage of birds which froze when placed in the Field was also measured. This was found not to show such a clear trend with age, changing from 50% on day 1, to 20% on day 8, 50% between 15 and 45 days and then decreasing to almost zero between 60 and 90 days. In addition, six 1-year old birds were exposed daily to the Open Field for 10 days and their mean activity increased over days; however it was not stated how this activity was measured.

Evidence that freezing was indicative of a relatively high level of fear was obtained from an experiment in which chicks were raised either in visual isolation, or with other chicks and/or toys, (Candland, Nagy and Conklyn 1963). At 25 days of age each chick was tested in an Open Field where another chick, toys and a novel moving object were visible. It was presumed that the chicks which had been reared in isolation and to whom all these objects were thus novel, would be most afraid and indeed a greater percentage of these chicks did freeze in

the test situation than did chicks reared in groups or with toys. Further, time spent freezing and the presence of the defaecation response, as opposed to it absence, were positively correlated.

Salzen (1962) described the responses of chicks to a strange environment in terms of fear of the "static ground". He stated that freezing is a chick's immediate response to such a situation and believed the unusual silence to be important in releasing it. This freezing was followed by peeping and movement. Salzen did not explain how his chicks were transferred to the strange environment so that the possibility of the freezing response having partly resulted from handling cannot be discounted. However an initial lack of mobility was also described amongst chicks which had not been directly handled but transferred to an Open Field in a special box (Sluckin, Fullerton and Guiton 1970). They used the latencies to stand up and move away as indicative of a chick's level of fear. Salzen (1962) argued that <u>all</u> chicks, regardless of age or of previous experience would show fear of a strange "static ground" since all chicks would have a familiar static world with which to compare the strange one. On the other hand, only chicks with experience of moving objects would show fear of what Salzen described as "strange moving figures".

Relatively few studies mention defaecation as a response in a strange environment. Presumably this means that it was not often observed and in fact Phillips and Siegel (1966) did state that it was not a response in any of their chicks of less than 72h of age.

b. <u>Peeping</u> It has often been observed that a very common response shown by young chicks to environmental change is peeping. For instance Candland and Nagy (1969) found the percentage of White Leghorn chicks

peeping at 15 days of age less than that at 1 day of age; after 15 days of age peeping was not prevalent. However such peeping may not be a response solely to environmental change. It may also be elicited by a drop in temperature (Kaufman and Hinde 1961, Fullerton, Berryman and Sluckin 1970). It has in fact been suggested that the temperature change alone could have caused a maximal peeping response so that the additional stimulus of a change in environment may not have resulted in any further increase (Fullerton et al 1970). But when other factors such as temperature were controlled peeping has been found by some authors to increase as a function of amount of environmental change (Fullerton et al 1970, Sluckin et al 1970) and by others not to show such a monotonic relationship with presumed level of fear. For instance Hogan (1965) found peeping increased with a moderate change in environment such as placing a chick in a familiar cage in an unfamiliar part of the room, but to be inhibited by a severe change - placing a chick in a familiar cage in a totally unfamiliar room. Active escape patterns such as jumping at the walls, and also defaecation both followed a similar pattern of change to peeping. Hogan thus suggested that while a moderate level of fear inhibited general activity and facilitated peeping and escape, a high level of fear inhibited also these patterns, the subject remaining silent and asleep. Later experiments supported this suggestion. Peeping was found to increase with repeated exposures to a strange environment, a procedure which was presumed to lead to a decrease in fear level. Peeping must therefore have been inhibted during the earliest, most fearful exposures. In the same experiment (Montevecchi, Gallup and Dunlap 1973) exposed chicks just before the Open Field Test to stimuli they presumed would increase their general level of fear - a loud noise or an electric shock. The time spent freezing by these chicks when placed

in the Open Field was in fact greater than that of controls, but the time spent peeping by these apparently more fearful chicks was less than that of controls. In another study (Ginsburg, Braud and Taylor 1974) which demonstrated an inverse relationship between peeping and other measures of fear in the Open Field Test some chicks were handled for several days prior to the Test. The handled chicks, in comparison to the unhandled ones, spent less time freezing and showed more activity (measure was the number of floor units crossed), both of which were taken as indicative of lower levels of fear, but they also showed a greater amount of peeping.

Peeping by chicks in an Open Field is influenced by factors other than experimentally manipulated levels of fear. Peeping was found to increase with age at first test from 1 to 3 days old in chicks which had been reared in groups but not in those reared in visual isolation (Kaufman and Hinde 1961). However in another experiment there was no difference in peeping in an Open Field between chicks reared in groups and first tested at either 1 or 4 days of age (Fullerton et al 1970). The exact position in the Open Field in which the chick was placed also affected peeping; more peeps were emitted by chicks placed in the centre of a Field than from those near a wall (Sluckin et al 1970).

The above examples demonstrate that extreme caution is needed in interpreting the amount of peeping shown by a chick in an Open Field type of situation in terms of the chick's level of fear. It will obviously rarely be possible to simply state that the more, or even the less, a chick peeps the more afraid it is.

c. Summary The foregoing results indicate that even 1-day old chicks have learnt the static characteristics of their home environment. They are able to perceive strange environments as such

and respond fearfully to them. Responses may take the form of a total lack of movement or of increased movement such as pacing and jumping at the walls. Peeping is a common response but influenced by factors such as age and social experience. Further, peeping has been described as incompatible with the freezing response (Salzen 1962, Phillips and Siegel 1966, Kruijt 1964) and to some extent incompatible with active avoidance responses (Guiton and Sluckin 1969). The majority of evidence seems to indicate, though by no means conclusively, that peeping is indicative of a more moderate level of fear than is silence and lack of movement.

6. The behaviour of other species in an Open Field

Before concluding this section on the responses of animals placed in a strange environment the few studies which have not used rodents or chicks as subjects will be described. In a comparative study, Candland and Nagy (1969) observed not only rats and chickens in an Open Field but also squirrel monkeys and cats. One of their main conclusions was that defaecation and activity, the traditional rat measures, were obviously not useful measures of emotionality in the other species. None of the monkeys defaecated at all and only half of them moved. Further, movements were in three dimensions rendering useless the standard two-dimensional measure of activity, the number of floor units crossed. In the case of cats and of kittens there was also no defaecation, but vocalisations were abundant and the authors suggested that their measurement might be of most use in determining levels of fear.

Growing pigs were isolated in a strange enclosure for 10min and three measures of their behaviour taken (Fraser D. 1974). These were, vocalisations of three types; the number and weight of defaecations; and the number of floor sections entered per minute. The incidences of two of the vocalisations, long grunts and squeals, were sufficiently correlated both with each other and with measures of activity and frequency of defaecation to suggest that all these measures might be related to some single aspect of differences among individual animals. The incidence of short grunts and the weight of faeces correlated less consistently with the frequency of squeals and long grunts and with the activity measure. Scores of individual animals on one test correlated substantially with scores on subsequent testing. The author concluded that only long grunts and squeals could be used alone as measures of individual differences in "emotionality". The activity score was too crude since it measured only quantity and not quality of movement. Defaecation did not consistently correlate with the other measures and may have been affected by nutritional factors. It should thus only be used as a corroborative measure together with the others.

EXPLORATION - A LITERATURE REVIEW

1. Exploration in the Open Field Test

When placed in an Open Field rats not only defaecate, they also move around. This movement was termed "ambulatory activity" and Hall (1936) found that defaecation, as measured by the number of days during which an animal defaecated, and ambulatory activity as measured by the distance moved per unit time, were negatively correlated. No independent motivating force was ascribed as responsible for this movement around the Field but Hall stated that it was inhibited by the high state of emotionality, or fear, present during an animal's first trials there. Similar negative correlations between defaecation and ambulation were demonstrated by, for example, Biel and O'Kelly (1940) and Denenberg and Morton (1962). But there have been rather more cases in which there was no correlation at all (Anderson 1938 a and b; Willingham 1956, Broadhurst 1958 b, Pare 1964, Ader, Friedman and Grota 1967). These discrepancies are perhaps not surprising for not only was no common method for measuring defaecation used but a variety of measures of ambulation were employed. These mostly involved the number of sub-units of floor area crossed by an animal per unit time, with disagreement on both the actual and relative size of the sub-units and on the number of paws a rat had to place in one for a crossing to be scored. A single author alone has used three different measures - the number of 15" units traversed in 10min (Montgomery 1951), the number of 12" units traversed during each minute of a 5min exposure (Montgomery 1953 a) and the number of 8" sections traversed per 2min (Montgomery 1955).

In a series of experiments Montgomery and co-workers were among the first to suggest that the autonomous drive of exploration was the

motivating force behind a rat's activity in a strange environment. In fact they defined exploratory behaviour as "the locomotor behaviour of rats given their first exposure to simple mazes that contain no extrinsic rewards such as food or water" (Montgomery and Monkman 1955). They offered no explanation as to why they felt this definition should be restricted to "simple mazes" and not any strange environment nor why it should be specific to a "first exposure" or to "rats". This definition was of course put forward at a time when Hull's concept of the "energising function of drive" was still in vogue and Montgomery made use of this concept in proposing that it could not be fear that was activating locomotor behaviour. For rats which were exposed to the sound of a buzzer when in a strange environment showed less activity than non-exposed controls. The buzzer, it was stated, would have increased the fear level of the rats, thus if activity were motivated by fear, activity should have shown an increase in those rats exposed to the buzzer. Since it did not, then fear could not have been the motivating force (Montgomery and Monkman 1955). This argument, of course, could not stand up to criticism. Firstly no independent evidence, either physiological or behavioural, was supplied to verify that the buzzer increased the rats' level of fear. Secondly there is an abundance of data, concerning several behaviour systems, which indicates that the relationship between motivational factors and performance is not linear but rather an inverted-U function (Hinde 1970). This would certainly seem to be true of the fear system and activity. Extremely high levels of fear may result in a total lack of activity, hence the phrase "paralysed by fear"; or in a very high level of activity with the animal wildly running around "in a state of panic" as for instance a bolting horse does.

Later Montgomery (1955) did concede that novel situations such as a maze do evoke fear as well as exploration and that both might affect an animal's activity. There can be no doubt that this is the case, for whether approaching to explore or withdrawing in fear an animal must move. Thus any attempt to measure either of these tendencies in an Open Field with a purely quantitative measure of locomotion is bound to fail.

Welker (1957, 1959) maintained that if ambulation was to be used as a measure of an individual's exploration of a strange environment then the subject must be free to enter and leave this environment at will from its home environment. Only then could one be sure that it was probably exploration and not fear that was motivating the animal's activity. This seems a logical argument. In comparing the ambulatory activity of rats in such a "free exploration" situation with that of rats in the traditional Open Field or "forced exploration" situation Welker did in fact find significant differences. Much less activity was shown in the free than in the forced situation, suggesting that in the latter case the presence of fear was causing a relatively high level of activity, presumably as the animal searched for an escape. This dependence of the amount of ambulation shown upon whether or not the animal was able to escape from the strange environment was however found not to exist in some other rodent species (Glickman and Hartz 1964).

2. Exploration as an autonomous system

Although Montgomery's method of measuring exploration was obviously unsatisfactory the work did draw attention to the fact that exploratory tendencies as well as fearful ones were probably influencing rats'

Open Field behaviour. This was an important step for although it has never been disputed that states such as hunger, thirst, fear, sex or aggression motivated behaviour the fact that exploration could also do so had to fight for recognition. Early publications on exploration concentrated on this aspect. Dashiell (1925) reported that satiated rats would wander around an empty maze; they would even cross an electrified grid to reach a maze (Nissen 1930) or an empty box (Warden et al 1931). The exploration of rats in a maze, as measured by the number of floor units crossed, decreased rather than increased when the animals were made hungry or thirsty (Montgomery 1953 a); and it did not change if rats were prevented from being normally active before the test (Montgomery 1953 b). The conclusions drawn were that exploration was not motivated by hunger or thirst or any "general activity drive" but must be an "autonomous drive". Once this had become generally accepted the emphasis changed to defining the stimulus situations which would elicit exploration.

3. Exploratory stimuli

Exploratory stimuli have been classified and defined by several authors:-
Harlow (1953) stated that "Exploration is aroused externally by novel or interesting stimuli that suddenly confront the animal".
Berlyne (1960) believed novel stimuli evoked exploration. A stimulus could be "absolutely novel", having some quality the animal had never experienced before. Or, it could be "relatively novel" possessing familiar elements or qualities in a combination or an arrangement which was new to the animal. Just how novel a stimulus would be to an animal was related to how often, how recently and how similar it was to other stimuli which an animal had previously encountered. But how, asked Berlyne, did one objectively measure "similarity"? Alternatively,

novelty could be measured on a temporal basis. Stimuli were "completely novel" if they had never been encountered before, they had "long-term novelty" if they had not been encountered for a period of days and "short-term novelty" if not encountered for merely a few minutes. It will be noted that all of Berlyne's criteria of novelty required an intimate knowledge of the animal's past experiences and would therefore be of no use for studying wild-dwelling or even wild-reared animals. Fowler (1965) stated that exploration resulted from novel stimuli or, more broadly to a change in stimulation. For instance rats chose to explore that arm of a maze which had changed in brightness since their previous exposure to it (Kivy, Earl and Walker 1956). Complex stimuli such as a black and white striped pathway were chosen by rats in preference to relatively simple stimuli, in this case a pure black pathway (Dember, Earl and Paradise 1957). The extent of the novelty, change or complexity of the stimulus situation was positively correlated with the amount of exploratory behaviour shown, as measured either by amount of locomotory activity (Montgomery 1953 C) or by a simple choice procedure (Dember and Millbrook 1956). Also, a part of the environment containing numerous and complex stimuli was explored more than one containing a few and simple stimuli (Berlyne 1955).

The stimuli which cause domestic fowl chicks to approach and peck have been extensively investigated, mainly in imprinting studies. For instance Schaefer and Hess (1959) using Vantress broilers, Gray (1961) using White Rock chicks and Abercrombie and James (1961) with Barred Rock X Rhode Island Red chicks all found that round objects were especially attractive to young chicks. Objects had to be relatively small, about 2.5 cm in diameter, to elicit pecking but could be up to 15 cm to elicit general approach (Schneirla 1965). The relative effectiveness of various colours appears to depend on many variables some of which have been studied by Berryman, Fullerton and Sluckin (1971), Kilham,

Klopfer and Oelke (1968), Kovach (1971) and Schaefer and Hess (1959).

4. Exploratory responses

Exploratory responses have also been variously classified and defined:-

Berlyne (1960) defined three categories of response:

1. Orientating responses. "Changes in posture, in the orientation of sense organs, or in the state of sense organs".

2. Locomotor responses. Locomotor movement throughout the area being explored.

3. Investigatory responses. "Responses which affect changes in external objects by manipulating them or otherwise".

Hinde (1970) maintained that exploratory responses were so diverse that the only definition possible was that "they are such as to familiarise the animal with its environment or with a source of stimulation". But he also distinguished between the orientation response, associated with immobility, and active exploration involving movement with respect to the area or object under investigation, the two responses being mutually inhibitory.

Hughes (1968) chose a more vague definition saying that exploratory behaviour was "activity which facilitates familiarisation with an environment by bringing the receptors into closer contact with components of the external stimulus field".

Probably the vaguest definition of all was that of Fowler (1965) who, concentrating on the apparent lack of identifiable motivation for exploratory behaviour, defined it as "those behaviours that seem unrelated to any goal object or condition of reinforcement - behaviours that appear to be for their own purpose". Such a negative definition, Fowler himself said, is unsatisfactory.

5. Factors affecting the type and intensity of exploratory response shown

a. The stimulus situation For instance the orientation response can only be shown to a discrete stimulus and not to a strange environment as a whole.

b. The presence of conflicting motivational states The effects of hunger on the exploratory behaviour of rats has been widely studied and the results are somewhat conflicting, showing that variables such as age, sex and type of novel stimulus all affect the relationship between these two tendencies. Montgomery (1953 a) found 24h of food deprivation to significantly reduce the amount of exploration (measure was the number of 12" units crossed) shown by 100-day old female rats in a maze whereas Lester (1967) found a similar measure to be unaffected by 120-day old males of the same strain. Hughes (1965) found no affect of food deprivation on rats' exploration of a strange box (measure was the number of 10s periods spent in the box and the percentage of novel units entered); but Berlyne (1960) stated that hungry rats preferred to explore unfamiliar stimuli than to eat and Fehrer (1956) reported that hungry rats showed more exploration than satiated ones of a strange environment adjoining the home cage.
The presence of fear also influences exploration, this will be discussed at length on page 83.

c. The species or breed of animal The actual mode of exploration varies according to each species' sensory capacities. Thus rats and dogs explore predominantly by smell, birds by vision and primates by touch, sight & taste At least two theories have been proposed concerning the amount of exploratory behaviour shown by different species. Glickman and Sroges (1966) believed it was positively related to the needs of each species to search actively for food and to escape from danger in their natural

environment. This belief was based on observations on over two hundred zoo animals including primates, rodents, carnivores and reptiles which were given the opportunity to explore novel objects such as blocks of wood, chains, rubber tubing and pieces of paper placed in their home cages. Morris (1964) also believed the amount of exploratory behaviour shown by a species to be positively related to its need to search for varying sources of food.

A somewhat different view was held by Wunschmann (1963) and based on observations on fish, birds and a single chimpanzee. He found that the amount of exploration shown towards novel visual patterns was positively correlated to the degree of complication of central nervous system organisation of the species. However the two above theories are not necessarily in conflict, for they apply to different dimensions of inter-species comparison. On the broader basis of comparison between different vertebrate classes Wunschmann's ideas will hold true. The process of exploration is basically one of learning about the environment. Since learning capacity is related to degree of CNS organisation, exploration will presumably also bear a relationship to this variable. Within any class or order, in which CNS differences are relatively slight, it makes good evolutionary sense that exploration should be related to factors such as the need to search for varying sources of food.

The domestication of a species may also cause changes in its exploratory tendencies. Wild rats showed extreme avoidance of novel objects placed in the home environment; when their food container was changed they stopped eating completely for several days. However this "neophobia" was not nearly so marked in domestic rats (Barnett 1955).

d. Age of animals Chaffinches and great tits of a few weeks of age approached and investigated a stuffed owl but older birds did not (Hinde 1954). Younger mammals of several species were more curious than adults, approaching and exploring situations from which adults withdrew (Bronstein 1972, Glickman and Sroges (1966).

e. Preceding sensory deprivation Hinde (1970) quoted various experiments in which animals were deprived of locomotor activity or of vision before testing. The effects of such deprivation on the amount of subsequent exploratory behaviour were not clear and Hinde concluded that even if exploration did increase in these circumstances one could not assume that it had done so for the same type of reasons that eating increases after food deprivation.

f. Time of testing The investigation by rats of a novel piece of apparatus was significantly greater at some times of day than at others (File and Day 1972).

6. The relationship between fear and exploration

a. Common stimuli As soon as exploration began to be studied as a system in its own right it became obvious that there is much in common between exploration and fear. In particular the stimulus situations which evoke the two types of response are very similar in many aspects. If any one word had to be chosen to broadly describe fear stimuli and one for exploratory stimuli, then in both cases the same word - novelty - would probably be the most appropriate. In fact "novelty" is often quoted as evoking both tendencies (e.g. Berlyne 1960, Montgomery 1955). Considering the biological functions of the two systems this overlap is inevitable. The exploration system provides an animal with information about its environment which may be of immediate or later use in escaping from predators, finding food, a mate

or a shelter. The fear system also provides an animal with information about its environment and ensures, by a combination of learned and unlearned processes, that actual and potential danger is perceived and responded to in a manner most likely to ensure survival.

Whether a novel stimulus is responded to with a fearful or an exploratory response seems to depend partly upon the extent of its novelty; extreme or intense novelty will evoke fear but moderate novelty will evoke exploration (Berlyne 1960). An individual's past experiences also influence the type of response given and, using Berlyne's (1960) terminology, a stimulus that is "absolutely novel" to one animal may be only "relatively novel" to another. One cannot therefore categorically state that "dogs are afraid of open umbrellas" or "rats will explore mazes" for although one dog and one rat may respond in these ways, others may respond differently. This is perhaps an obvious point but it is one that needs to be emphasised.

b. Common responses When a stimulus, whether visual or auditory, is presented to an animal it is very likely that it will show an orientation response to that stimulus. If the animal then approaches the stimulus the orientation response is classified as having been exploratory, but if it withdraws then the orientation was a fearful response (Hinde 1970). In the domestic fowl the orientation response generally takes the form of visually fixating the stimulus object and this has been classified as representing both a low level of fear (Hogan 1965, Hughes and Black 1974), and a low level of exploration (Horne and Wood-Gush 1970).

c. Common motivation? Because of the similarities in stimuli and responses several authors, including Berlyne (1960), Johnston (1964) and Fraser A.(1974), have expressed the belief that fear and exploration

should be regarded as a single system within which high levels of motivation result in fear responses and low levels in exploratory responses. Experimental evidence put forward in support of this single-system theory includes:-

1. The exploration of rats, measured by ambulatory activity, varied with the fear-producing properties of a strange environment, measured by the amount of defaecation (Halliday 1966).

2. Factors such as a lack of handling and individual housing, during the rearing period, which are both believed to affect a rat's level of fearfulness also affect its level of exploration (Thompson and Lippman 1972).

However in the above cases it is obvious that no actual proof that fear and exploration form part of a continuum was established, merely that they could both be influenced by the same external variables.

Objections to the single-system theory include the following:-

1. Animals frequently alternate between showing fear of a strange object and exploring it (Harlow and Zimmerman 1958, Hinde 1970). If a single underlying motivational state were involved such fluctuations in response type should not occur. Rather there should be a gradual merging of one response type into the other.

2. In rats the traits of fear and exploration were found to be orthogonal to each other in a factor analysis of the results of a large variety of tests (Whimbey and Denenberg (1967).

3. Within several inbred strains of rat no consistent relationship was found between the exploration of a strange environment (measure was the latency to poke the head out of the home cage into the strange environment) and the "known emotional characteristics of each strain" (Harrington 1971).

Studies on the type of behaviour evoked by electrical stimulation of the brain have unfortunately been of little help in determining the relationship between fear and exploration. Taking the domestic fowl as an example, Putkonen (1967) reported that although it was often difficult to classify the behaviour patterns elicited, attention or orientation responses could often be evoked with a relatively low current from sites that produced fear reactions with a higher current. While this would seem good evidence for the single-system theory, Phillips and Youngren (1971) were able to produce the fear reaction of panic from almost any site by the use of a fairly high current; further, they found fear and escape responses to be extremely variable in occurrence both between birds and between electrodes.

But are these theoretical arguments of use? A motivational state, or drive as it is often referred to, is after all only a concept derived to provide an easier understanding and explanation of the changing relationship between stimuli and responses. It is not an observable and measurable entity in the sense that a stimulus or a response is. Although not doubting the uses of theoretical constructs, their discussion should not take precedence over what many may regard as more mundane questions. Baumeister, Hawkins and Cromwell (1964) summarised the situation well, "the use of constructs such as drive to explain certain behaviours seems to be inversely related to an understanding of the conditions under which these behaviours develop". Since relatively little is known about the fear and exploration systems, in particular about how to rank behavioural responses it would surely be of more benefit to concentrate first on these more practical areas of research. Further, the more basic data which is available, the easier should become the formulation of theoretical constructs.

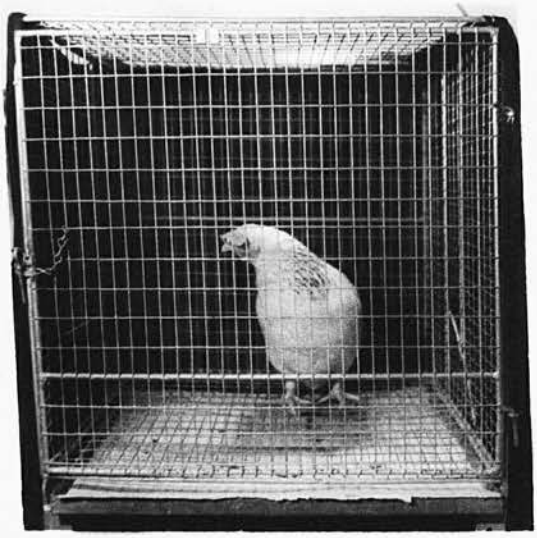
CONCLUSIONS TO LITERATURE REVIEW

Wild animals need to avoid predation and other dangers and to seek out food, shelter and a mate. These needs have resulted in the evolution of complex stimulus-response contingencies which may be respectively referred to as the fear and exploration systems. To a certain extent the stimuli and responses involved in the two systems overlap but some are mutually inhibitory. There has been much diagreement about whether one or two underlying motivational states are involved in the two systems. However this lack of theoretical knowledge is insignificant compared to our lack of practical knowledge on how to best define fear and exploratory stimuli and how to measure and rank responses.

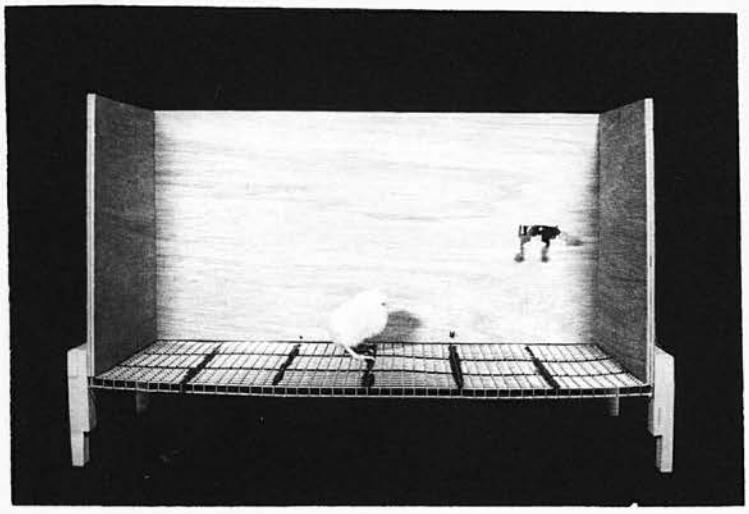
Both effective stimuli and responses vary with many factors including the species, strain, sex, age and previous experience of the animal being studied. In both systems the stimulus which is most universal in its effectiveness is undoubtedly "novelty". By far the greatest proportion of the literature on fear and exploration concerns the responses of rats when placed in a strange environment from which they have no means of escape. But since by its nature this situation evokes both types of response its usefulness for measuring either is very limited.

Plate 6

The experimental cages in which birds were isolated in the sound-proof room.



A mature bird in the cage used for all birds of 6 weeks of age and older.



A 7-day old chick in the cage used for all chicks of 2 weeks of age and younger. The front and roof of the cage have been removed so that the relative sizes of chick and cage may be clearly seen.

EXPERIMENTAL SECTION

1. The responses of birds to a strange environment

Introduction As described in the preceding literature review there are basically two sources of novel stimuli which an animal may encounter. One is a novel environment and under natural conditions this would adjoin the home environment. The other stimulus is a novel object/s found within the home environment. The initial responses shown by animals to both types of stimulus are generally classified as either fearful or exploratory. The first experiments in this section (nos. C 1-C 10) investigated the responses of birds of various ages to a strange environment. In an attempt to arouse different levels of fear or exploration in the birds, environments which differed from the home one in many or in few aspects were used. Also, in some cases birds were able to enter and leave the strange environment at will, whilst in others there was no means of escape.

Experiments C1-C5

Object To compare, at various ages, the responses of birds of the two stocks to forced confinement in an environment which differed from their home environment in many aspects. Thus the experiments were in essence similar to the "Open Field Tests of Emotionality" described in the Literature Review.

Materials and Methods Birds were observed in the experimental cages in the sound-proof room, described in the General Notes Section, see Plate 6. As well as the extreme silence of this environment, broken only by the ticking of a clock, the light intensity was much higher than that of the birds' home environments. It was also the first time

that any of the birds, apart from those chicks specially reared in isolation, had been separated from the company of other birds.

The experimental procedure was as follows: birds of 6 weeks and older were carried from their home area to the experimental cage supported from underneath and with the bird's head covered by a loose cloth. Chicks were carried lying on the palm of the experimenter's hand with the other hand cupped over, but not touching, the chick's head. These methods of restraint had previously been found not to result in tonic immobility when the bird was released. With the room in complete darkness, the bird was placed standing in the centre of the cage, facing the front. The experimenter retired behind the cloth screen, switched on the light and clock and began observations. The average time taken from removing a bird from its living area to the start of observations was 45s. A continuous written record was made of each bird's activities for 15min. Locomotion was scored as the number of individual steps taken, and a qualitative description was also made.

Experiment C I

Object To compare the responses of mature, laying birds of the two stocks to a totally strange environment.

Subjects Fourteen laying birds of each stock, approximately 9 months old were observed. They were normally housed in single-stock pens containing six to eight birds and had been handled daily for several months to detect the presence or absence of an egg in the oviduct. All were observed on a day when they were not due to lay.

Results No significant differences were found between the two stocks on any of the behaviour patterns observed, see Table C 2 A. The birds spent on average, half the time standing and half lying and each bird took an average 35 to 45 steps, these usually being taken in what is best described as a very "wary" manner. Only three birds of each stock defaecated; preening, yawning, the performance of comfort movements and pecking at the environment were more common responses while vocalisations were less common. None of the birds froze and none paced or showed escape movements. The birds were obviously exploring the environment visually, and continually made small head movements. These were however so variable in magnitude and speed that they proved impossible to quantify.

Experiment C 2

Object To compare the responses of 14-week old birds of the two stocks to a totally strange environment.

Subjects Ten birds of each stock, normally housed in communal rearing cages were observed. They had not been regularly handled.

Results In general terms these birds behaved very similarly to the mature ones of the previous experiment, see Table C 3 A. Only one additional behaviour pattern was shown by the 14-week old birds; this was performing escape movements with the head at the front of the cage. There was one significant difference between the two stocks. Birds of the docile stock defaecated more often than those of the flighty stock ($p < 0.02$, Mann-Whitney U-test, 2-tailed.)

Experiment C 3

Object To compare the responses of 10-week old birds of the two stocks to a totally strange environment.

Subjects Twelve birds of each stock were observed; they had been previously kept as the birds of Experiment C 2.

Results There was a slight tendency for birds of this age to respond to the situation with more active attempts to escape than the older birds had done. A total of eight birds displayed escape movements with the head and four jumped up at the walls. "Eyes closed" was relatively less common than amongst older birds. Vocalisations were common but difficult to identify, since at this age the sounds produced vary greatly from bird to bird and do not closely resemble the uniform clucking or alarm calling of mature birds. Nonetheless the vocalisations made in the experimental situation seemed to indicate distress. The only significant stock difference concerned the number of these vocalisations, flighty-stock birds emitting them more often than docile-stock ones ($p < 0.02$, Mann-Whitney U-test, 2-tailed). Less than half of the birds defaecated during the 15min observation. The data are presented in Table C 4 A.

Experiment C 4

Object To compare the responses of 6-week old birds of the two stocks to a totally strange environment.

Subjects Fifteen birds of each stock, normally housed in the chick brooder, were observed. They had not been regularly handled.

Results A behaviour pattern not occurring amongst any of the older birds was shown by some of the 6-week old birds. It was best described as "flying across the cage" and was shown by ten flighty-stock and three docile-stock birds ($\chi^2 = 5.89$, $p < 0.02$). A total of six birds showed escape movements with the head and two jumped up at the walls. Only one bird of each stock closed its eyes during the observation period. Peeping still occurs at 6 weeks of age and more than half of the birds of each stock spent some time peeping during the observation. Defaecation was much more prevalent at this age than amongst the older birds; all but three birds defaecated at least once. In both stocks the mean number of steps taken was greater at 6 weeks than at any of the older ages; but, as with the older birds there were no stock differences in these numbers. Birds of the docile stock pecked at the environment significantly more often than birds of the flighty stock ($p < 0.05$, Mann-Whitney U-test, 2-tailed).

The data are presented in Table C 5 A.

Experiment C 5

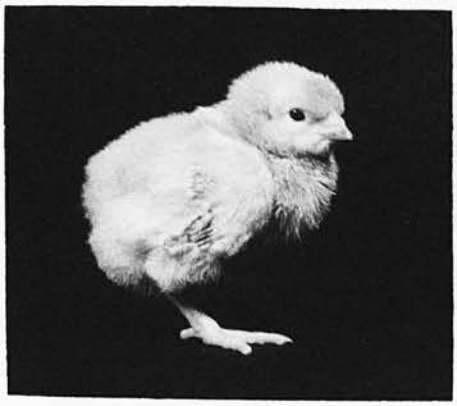
Object To compare the responses of chicks of the two stocks to a totally strange environment and to determine the effects of age at testing and of social conditions during rearing on these responses.

Materials and Methods Eighty-four chicks of each stock were observed. At hatching they were assigned at random to one of six groups, each having fourteen chicks. There were two rearing treatments, reared in visual isolation from other chicks, or in groups of four; and three ages were observed, 4, 7 or 14 days. Together with the two stocks this gave a 2 x 2 x 3 factorial design. After hatching the chicks were placed in standard chick-boxes until required for observation.

Results The behaviour shown by the chicks generally fell into one of two categories. Either they emitted peep vocalisations and this was almost always done by standing, as opposed to lying chicks, and sometimes by chicks which were moving around in the cage. Individual chicks peeped for up to several minutes without a break. Alternatively chicks lay down, in silence, and appeared to go to sleep. However the motor components of this behaviour pattern were very unlike those shown by chicks in their home environment. In its home box a chick will lie down and then simultaneously lay its beak on the ground in front of its body and close its eyes. The whole process takes about 2s and a chick will then usually sleep for 10-15min. In the present situation nearly all of the chicks which "went to sleep" did so in the following manner. A chick which was standing would close its eyes and its head would gradually fall forwards towards the ground until its beak came to rest on it. The chick would then usually open its eyes, raise its head, then soon close its eyes again and repeat the whole process. A

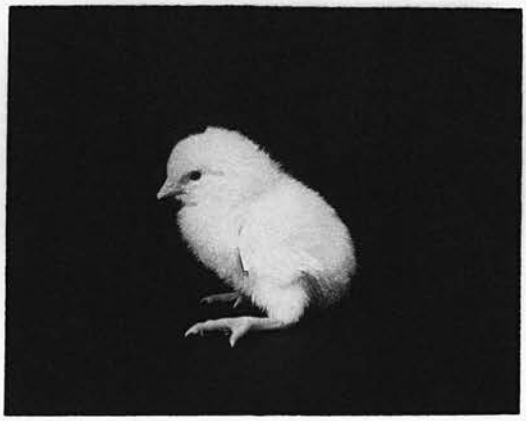
Plate 7

Three of the body postures adopted by chicks isolated in the cage in the sound-proof room.



Standing

Lying



"Sitting"

similar behaviour pattern was described for chicks placed in a strange environment in the presence of a strange moving model (Bateson 1964) and for chicks placed in a strange environment and exposed to a loud noise (Phillips and Siegel 1966). After three or four repetitions of this procedure a chick tended to slowly lie down and then rest its beak on the ground and close its eyes in the same way as described for chicks in the home environment. However a chick sometimes suddenly stopped continually opening and closing its eyes and remained standing and awake instead of lying down. Less frequently a standing chick did not "wake up" until some seconds after its beak had touched the ground and thus a very small proportion of the times recorded as "time spent with eyes closed" and "time spent with beak on ground" were accounted for by standing, and not by lying, chicks.

Of the one hundred and sixty-eight chicks observed, eighty-two engaged in both of the mutually inhibitory responses of eyes closed and peeping; forty-four showed only eyes closed and thirty-eight only peeping; only four chicks showed neither behaviour pattern. Seventy-two chicks (less than half) actually walked around within the cage; other behaviour patterns were still less common. Four chicks preened, nine pecked at the environment and only ten defaecated.

Sixty-one chicks adopted yet another stance which was never seen in the home environment. It looked like a posture intermediate between standing and lying and was termed "sitting". A sitting chick had its leg from the foot to the hock resting on the ground as when lying but its body raised well above the ground as when standing, see Plate 7. Chicks adopted this posture either between standing up and lying down or vice versa.

The distribution of these various behaviour patterns between the two stocks, two rearing treatments and three ages was extremely interesting.

In general terms standing, moving and peeping were each shown by significantly more docile-stock chicks than flighty-stock ones, by more chicks reared in isolation than in groups and by more 4-day old chicks than 14-day old ones. Conversely, lying down, eyes closed and beak on ground were each more commonly shown by flighty-stock chicks, those reared in groups and 14-day old chicks. The only frequently occurring behaviour patterns which did not conform to these trends were changing stance, which was evenly distributed amongst all classes, and sitting, which was shown by significantly more young chicks than old ($p < 0.02$) but also by significantly more group-reared than isolate-reared chicks ($p < 0.05$).

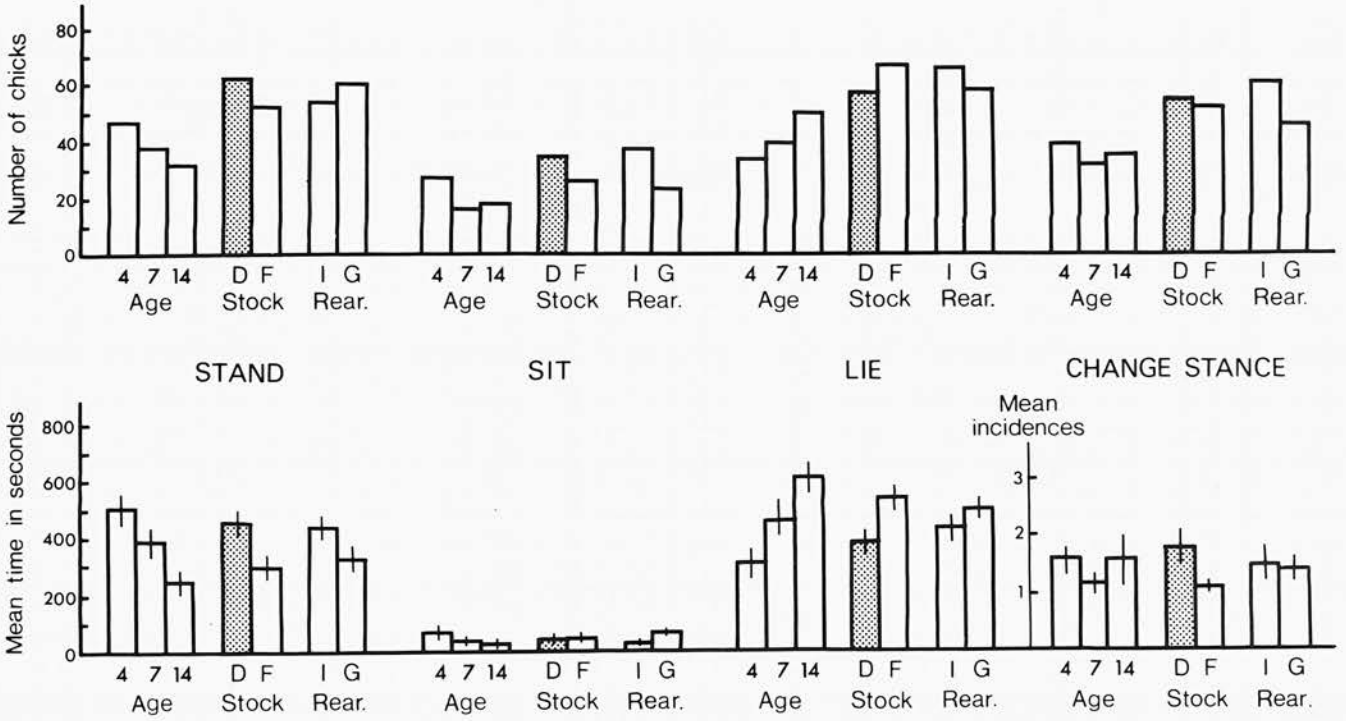
The number of chicks in each of the twelve classes which performed each of the behaviour patterns shown is given in Table C 6 A together with the results of the statistical analysis.

When nearly all of the chicks performed a particular behaviour pattern then the times or incidences of performance were compared by an analysis of variance. The analysis showed that in general docile-stock chicks spent more time standing, took more steps and spent more time peeping than did the flighty-stock chicks. Similarly 4-day old chicks performed these behaviour patterns to a greater extent than the older chicks and chicks reared in isolation more than chicks reared in groups. There were however some significant interactions which necessitate caution in the interpretation of the significant main effects. For instance there was a significant stock x age effect ($p < 0.05$) in both time spent with eyes closed and time spent with beak on ground. In each case this was because the 7-day old chicks of

Exp C5

Figure C1

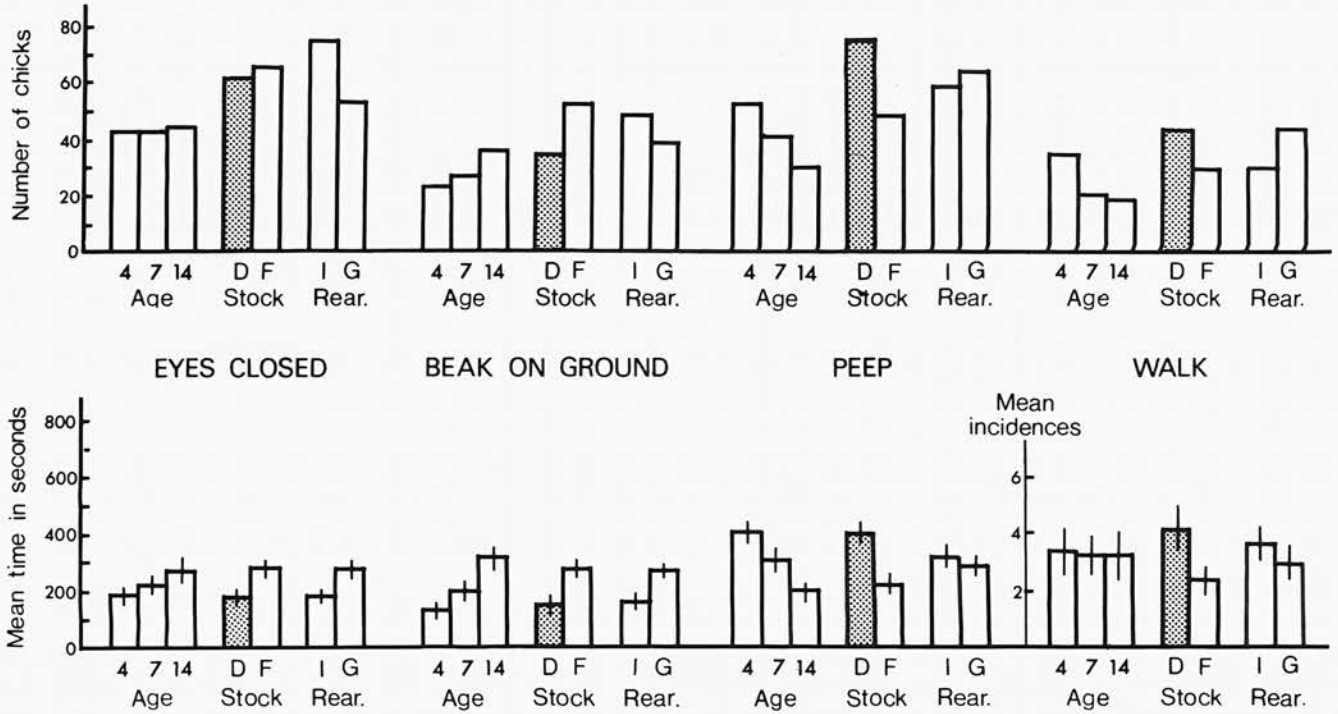
The behaviour of chicks isolated in a cage in the sound-proof room for 900s. The number of chicks of each age and of each stock and of each rearing condition which performed each behaviour pattern and the mean ± SE times (in seconds) or incidences of performance.



D = docile stock F = flighty stock I = reared in isolation G = reared in a group.

Figure C 1 Exp C 5

The behaviour of chicks isolated in a cage in the sound-proof room for 900s. The number of chicks of each age and of each stock and of each rearing condition which performed each behaviour pattern and the mean ± SE times (in seconds) or incidences of performance.



both stocks had mean values which did not conform to the trend shown by the main effect for age. The results of the analysis of variance are given in Table C 7 A.

Figure C 1 compares the three variables of stock, rearing and age in histogram form for the eight most commonly occurring behaviour patterns. Both the numbers of chicks performing each pattern and the mean times or incidences of performance are shown. The fact that docile-stock chicks differed from flighty-stock ones in the same direction that 4-day old chicks did from 14-day old ones and isolate-reared chicks did from those reared in groups is well illustrated in this Figure. It may also be seen here that the following behaviour patterns - standing, lying, beak on ground and walking - showed significant differences with age and with rearing treatment and with stock. The following showed significant differences in two of these three variables - sitting, age and rearing; eyes closed, stock and rearing; peeping, age and stock.
The results of this experiment are presented more fully in Table C 8 A.

Discussion of experiments C 1-C 5

A very striking feature arising from the results of these five experiments was that, with the exception of young chicks, there was a great lack of differences in behaviour between birds of the two stocks. The experiments of sections A and B showed large stock differences at all ages in birds' responses to a novel and approaching stimulus. Both a strange environment and strange objects are generally regarded as fear evoking, see Literature Review. It is true that in the strange environment there was at least one significant stock difference at each of the older ages observed. Since however at each age about twenty different behaviour patterns were observed and measured it is within the bounds of probability that the stocks would differ on one of these purely by chance. As it was not the same behaviour pattern at each age

in which the significant difference occurred suggests that these differences were in fact attributable to chance.

But why did birds of the two stocks at 6 weeks of age and older behave so similarly to each other? One possible reason is that the birds did not perceive that the experimental environment was strange and therefore showed neither fearful nor exploratory behaviour, but acted indifferently. To propose that an animal with the sensory capacities of the domestic fowl did not perceive the environmental changes involved is plainly ridiculous. Further, obvious fear responses such as alarm calling, clucking, performing escape movements or jumping up at the walls were shown by at least some birds at all ages. These behaviour patterns are not normally shown by birds undisturbed in their home cages. And after all, it is clearly of adaptive significance for any species not to ignore a strange environment but to respond fearfully to it and/or to explore it. King (1966) proposed that the fear system has evolved in all avian and mammalian species as a mechanism by which danger stimuli are perceived and then avoided. One might expect the fear system to have evolved in each species in proportion to the extent of danger present in its natural environment. Indeed many island-dwelling species which suffer little predation or other danger are known to be generally less fearful than related mainland-dwelling species (Huxley 1942). The ancester of the domestic fowl, the Burmese Red Jungle Fowl, inhabits what is presumably one of the most dangerous types of environment and a high level of fearful response to any type of novel stimulation is therefore expected in Jungle Fowl. Indeed the extreme wariness of this species has been specifically mentioned as one of their most obvious behavioural characteristics (Collias and Collias 1967). Naturally

it cannot be assumed that the domestic fowl, after hundreds of generations of artificial selection will have retained this high level of fear responses. In fact the experiments of sections A and B showed that although the white-stock birds appeared to have retained the innate withdrawal response to a novel and approaching stimulus it was lost in mature brown-stock birds.

Another possible reason for the lack of stock differences in responses of birds to the totally strange environment is that the environment produced such intense fear that all individuals of both stocks responded maximally, obscuring any stock differences in the amount of novel stimulation required to pass the threshold for fear responses. If this explanation is accepted it means accepting that a bird merely standing or lying and looking around but not alarm calling or pacing or freezing was experiencing a very high level of fear. For this is how the majority of birds of 6 weeks of age and older did behave - they did not give the appearance of being afraid. Physiological measures would of course help to confirm that they actually were afraid.

There was very definitely a trend between 6 weeks of age and 9 months of age for the younger birds to show more active attempts to escape from the strange environment, in other words to behave in a manner more obviously motivated by fear than the older birds did. While this trend may have been solely related to age the mature birds may also have been less active because they were normally housed in pens and inhibited from activity by the cage floor of the test situation. But they had been reared in cages up to 4 months of age.

In chicks of 2 weeks of age and under there were stock differences in several of the behaviour patterns observed in the test situation. But what did these differences indicate? Considering only peeping it might at first be concluded that the docile-stock chicks were the more afraid since they peeped for significantly longer than the flighty-stock chicks. However it has been suggested that peeping is inhibited at very high states of fear (Hogan 1965, Montevecchi et al 1973). So perhaps it was the quieter flighty-stock chicks which were more afraid.

None of the other behaviour patterns shown by the chicks were so obviously indicative of at least some degree of fear or distress as was peeping. Thus which of the two stocks was more afraid, if indeed either was, can only be surmised from the following type of argument. It is probable that the strange environment evoked more fear in chicks reared in groups than in those reared in isolation. The group-reared chicks were exposed to a strange social environment as well as to all the other strange aspects and Hebb (1953) listed solitude amongst fear-producing stimuli. It is also probable that the 14-day old chicks were more afraid in the strange environment than the 4-day old chicks. The older a chick the more familiar would be its home environment and thus the more strange the strange one would be; King (1966) suggested that the degree of fear produced increased with the degree of novelty that produced it. Further the age-related differences in times spent with eyes closed and with beak on ground were in the opposite direction to those shown by chicks of these same ages observed when undisturbed in their home environment (experiment I 1). This strongly suggests that the differences found in the present experiment were not solely a function of

maturation. Further, the chicks reared in groups did in fact differ from the isolate-reared ones in the same directions that the 14-day old chicks differed from the 4-day old ones. If it may be assumed that these differences which were found between ages and between rearing treatments were directly caused by differences in fear then there is evidence that the flighty-stock chicks were more afraid than the docile-stock ones. For the flighty-stock chicks behaved as did those reared in groups and those of 14 days of age, spending a longer time lying, with eyes closed and with beak to ground and with a shorter time peeping. And the docile-stock chicks behaved as did those reared in isolation and the 4-day old chicks, with a longer time spent standing, and peeping and taking a greater number of steps.

There is another possible explanation for the stock difference in the chicks' responses which ought to be mentioned. It is that the two types of response shown by the two stocks of chicks were not the result of two different levels of fear but were two different ways of expressing the same level. This is unlikely for the following reasons. It has generally been found that behavioural changes occurring during the process of domestication have taken the form of changes in the threshhold levels required to elicit a response and not in the basic motor patterns of the response (Hale 1969). Secondly the differences observed between the two stocks were the same as the differences observed between the different ages and the different rearing treatments and these differences were most probably attributable to differences in fear levels.

Four points of general interest concerning the fear system arose from experiments C 1-C 5.

1. They illustrated the necessity of observing animals of as wide a range of ages as possible. If only mature birds had been used it would have been concluded that the stocks did not differ in their responses to a strange environment; the opposite conclusion would have been drawn if only chicks had been observed.

2. The experiments showed the effects of age on the type of response given. Only amongst chicks did a large proportion of the subjects move around and vocalise to any extent. Any interpretation of these age differences in response in terms of different levels of fear could obviously not be made at this stage.

3. The effects of the type of fear stimulus on the type of fear response shown was demonstrated. The novel and approaching stimuli used in section B caused withdrawal sometimes accompanied by loud vocalisation. But in the strange environment of the present experiment it appeared that fear could also be expressed by silence and a complete lack of movement.

4. Another point concerned peeping. There was no significant difference in peeping between chicks reared in groups and those reared in isolation although age and stock did affect peeping significantly. This suggests that the changes in visual, auditory and tactile environment experienced were so great that the change in social environment was not sufficiently intense to elicit further peeping. This idea is in direct opposition to the findings of Kruijt (1964) and Fullerton et al (1970) who found loss of social companions to be a major factor in eliciting peeping. On the other hand there is much evidence indicating that a high level of fear inhibits peeping and on this basis chicks reared in groups could be expected to peep less than

isolate-reared ones in the present situation. In other words loss of only social companions probably leads to moderate fear resulting in increased peeping, but loss of social companions and of familiar static environment probably leads to high fear resulting in an inhibition of peeping.

The results of these experiments indicated several important differences between domestic fowl and domestic rats as regards the Open Field Test. One is that while the Test has been regarded as able to detect individual differences in fearfulness in rats (Hall 1934 b) it does not appear that it could be so used for fowl, at least of the two stocks used here, older than 6 weeks of age, because of its extremely high intensity as a fear-producing stimulus. Secondly, chickens did not defaecate as readily as rats apparently do. This difference is even more striking when it is remembered that rat Open Field Tests are usually much shorter than the 15min Test to which the chickens here were exposed. Candland and Nagy (1969) did however find defaecation a common response in White Leghorns over two weeks of age. These authors also reported freezing to be prevalent among birds of certain ages when first placed in an Open Field whereas none was observed in the present study. But since these authors did not describe how their birds were handled when being taken to the Open Field it is not possible to comment further on these discrepancies.

Experiments C 6-C 8

Introduction

In the preceding five experiments birds of various ages ranging from young chicks to mature laying birds were observed when isolated in an environment which differed from the home environment in many aspects. At 6 weeks of age and older no stock differences in the responses of the birds were observed and it was suggested that this was because the experimental situation induced maximum fear in all the birds and obscured any differences in fear thresholds.

In experiments C 6 and C 7 birds are observed in an environment which differed from the home environment in fewer aspects. The amount of fear induced by a novel stimulus has been regarded as bearing a direct relationship to the amount of novelty in that situation (King 1966). This idea was supported by Hogan's (1965) observation that the more strange a strange environment was the more fear was shown by young chicks. Extreme silence has been proposed as a major factor eliciting fear in birds in Open Field Tests (Salzen 1962). With the intention of inducing less than maximum fear in the following experiments and thus perhaps revealing differences in fear thresholds, a strange environment was used which had the same background noise as the home environment but differed fron it in other aspects.

On the other hand chicks of two weeks of age and younger did show stock differences in response to the totally strange environment. It was proposed that these were caused by different levels of fear and thus at least one stock, the docile stock, was not responding maximally. It did not seem possible to provide an even stranger environment which would possibly evoke maximum fear in all the chicks, resulting in the same behaviour. It was therefore decided to try and make the stocks

respond in the same way by minimising the amount of fear induced so that all chicks would be responding just at the threshold level. A strange environment was thus used which differed from the home environment in one aspect only - namely its social aspect.

Experiments C 6 and C 7

Object To compare the responses of mature and of 14-week old birds of the two stocks to a partially strange environment.

Subjects In experiment C 6 fifteen, battery-housed, laying birds were used at approximately 9 months of age. The subjects of experiment C 7 were twelve birds of each stock, 14 weeks of age and kept in rearing cages.

Materials and Methods From hatching all the birds had experienced only cages. The strange environment in which they were isolated was a pen 2.4m square, the floor of which was covered with wood shavings. With the exception of a water trough, placed against one wall, the pen was empty. Mirrors, placed high up on a wall out of a bird's view allowed the experimenter to see all parts of the pen from the observation post in the corridor adjacent to it. Average light intensity in the pen was considerably greater than in either the battery unit or the rearing cages. Background noise was however the same in all environments.

A method of placing the birds in the strange pen was used which (a) involved minimal contact between the birds and the experimenter and (b) allowed observations to be made on the birds' responses to a second strange environment, namely a small cardboard box. Experimental procedure was as follows. The experimenter removed a bird from its

home cage and placed it in a cardboard box, 45 x 25 x 20 cm high; dimensions which allow a bird to stand and turn around. The experimenter carried the closed box into the pen and placed it in the corner adjacent to the corridor. Once outside the pen the experimenter was able to open the front of the box by means of a string attached to a "door" cut out at one end of the box. Each bird was placed in the pen facing this door and thus when it was opened the bird could see out into the pen; the experimenter could see the bird inside the box in the mirrors on the opposite wall. The time required from removing a bird from its cage to opening the door in the box was approximately 40s.

The experimenter recorded all the activities of a bird inside the box including its direction of facing, whether standing or lying and how often it put its head outside the box, pecked the litter or at the box. After a bird had emerged from the box, emergence being defined as having both feet outside on the litter, its activities in the pen were recorded for a 15min period. The bird was then returned to its home cage.

Besides making qualitative observations the following quantitative measures of each birds' locomotion in the pen was recorded:-

1. Latency to take first step after emerging from box. This did not include any steps taken while coming to rest after flying or jumping out of the box.
2. The total number of steps taken. These were recorded on a hand counter.
3. The floor area of the pen was divisible, using the panels of the pen walls as markers, into nine 80 cm squares. The total number and variety of these squares entered, with both feet, was noted.

A portable tape recorder was used to record these and other behaviour patterns including preening, pecking the floor litter, defaecating and vocalising.

Analysis Since the birds varied in the total time spent in the box the times spent in different behaviour patterns by each bird were expressed as a percentage of their total time in the box and statistical analysis was carried out using these percentages.

Results

a. Behaviour inside the box - 9-month old birds

There was a very large stock difference in the time spent in the box before emergence into the pen. The mean $\pm$ SE time for the flighty-stock birds was 449 $\pm$ 109s and that for the docile-stock birds was much longer, 2245 $\pm$ 578s ($p < 0.002$) Mann Whitney U-test, 2-tailed. There were no stock differences in the percentages of time spent lying, or facing out of the box into the pen or into the back of the box. However the docile-stock birds changed stance more often ($p < 0.002$), put their heads out of the box more often ($p < 0.05$) than did flighty-stock birds and more docile-stock birds than flighty ones pecked at the litter ($p < 0.05$) and vocalised ($p < 0.02$).
The results are summarised in Table C 9 A.

The method of emergence from the box was markedly different in the two stocks. The docile-stock birds came out very slowly and cautiously, frequently half emerging and then retreating inside again. The flighty-stock birds tended to run or jump straight out without making a preliminary investigation of the area outside the box. Often they did not come to rest until they reached the wall at the opposite side of the pen.

b. Behaviour inside the box - 14-week old birds

The docile-stock birds again spent longer inside the box than the flighty-stock ones. ($p < 0.05$). Although they also pecked the box, put their heads out of the box and changed stance more often than the flighty-stock birds these differences were not quite significant at the 5% level. Methods of emergence from the box was as for the 9-month old birds.

The results are summarised in Table C 10 A.

c. Behaviour inside the pen - 9-month old birds

There were significant stock differences in all the measures of locomotory activity. The flighty-stock birds had shorter latencies to first step ($p < 0.02$) and they also took more total steps ($p < 0.002$). Birds of the flighty stock entered a greater total number of squares ($p < 0.02$) and a greater number of the nine different squares ($p < 0.02$). There were also qualitative differences in locomotion. Much of the movement of the flighty-stock birds was a hurried walking around the perimeter of the pen in an alert posture with head and neck stretched upwards. The birds of the docile stock tended to move much more slowly and deliberately, looking around themselves all the time and in a relaxed posture. Sudden bursts of running or flying across the pen, possibly released by its unaccustomed large area, occurred fairly equally between the two stocks. Preening, wing-flapping and other comfort movements were common and similar in incidence in both stocks. Ten birds of each stock defaecated with the mean latency to defaecate being very similar in birds of both stocks.

The results are summarised in Table C 11 A.

d. Behaviour inside the pen - 14-week old birds

In all the measures of locomotion the two stocks differed in the same directions as in the older birds, see Table C 12 A. However the only significant difference was in the number of different squares entered,

flighty-stock birds entering more than those of the docile stock ($p < 0.05$). The same difference in the quality of the locomotion decribed for the mature birds applied to these younger ones. Running and flying across the pen, pecking litter and the performance of various comfort movements were again fairly frequent behaviour patterns and did not differentiate the two stocks.

Discussion The partially strange environment seemed to have had the desired effect of evoking less than maximum fear, thereby revealing what was probably a stock difference in the fear threshold to this environment. The possibility still exists however that the differences in behaviour reflected the same level of fear in birds of the two stocks but, as mentioned in the discussion of the previous experiment, such qualitative differences in behaviour by birds of the same age and history and to the same situation are extremely unlikely. Thus, assuming that the different types of response shown by birds of the two stocks resulted from different levels of fear two questions remain to be answered:-

1. Which of the two stock's responses represented the greater level of fear both (a) in the box and (b) in the pen?

a. In the box. The docile-stock birds remained in the box longer than those of the flighty stock. This may have been either because the docile-stock birds were more afraid than the flighty-stock ones of entering the pen, both stocks being equally afraid of being in the box; or because the flighty-stock birds were more afraid than the docile-stock ones of being in the box, both stocks being equally afraid of the pen. The purely quantitative measure of time spent in the box cannot therefore be reliably used to compare levels of fear.

However from the qualitative observations on the birds' behaviour while inside the box more meaningful conclusions may be drawn. The flighty-stock birds typically lay quite still in the box until suddenly leaping out. The docile-stock birds on the other hand were obviously much more at ease in the box for they moved around in a relaxed manner and even pecked the cardboard. The pecking of a novel object by a domestic fowl has been classified as an exploratory response (Horne and Wood-Gush 1970) and as indicating an absence of fear (Hughes and Duncan 1972, Hughes and Black 1974). This all suggested that the flighty-stock birds left the box sooner because they were more afraid of being in it than the docile-stock birds were. But this did not necessarily mean that the flighty-stock birds were less afraid of entering the pen than the docile-stock birds were; the two situations must be viewed separately. Indeed only six of the fifteen mature and six of the twelve 14-week old flighty-stock birds actually looked out into the pen before they left the box. The remaining birds did thus not even have the opportunity to compare the two environments.

b. In the pen. Once out in the pen the flighty-stock birds moved around much more than the docile-stock birds. Did this mean that the flighty-stock birds were now the less afraid? Again the quality rather than the quantity of the birds' locomotion gave a valuable indication of its underlying motivation. The flighty-stock birds certainly moved around more than the docile-stock birds but this was because they were pacing up and down at the pen walls. The fewer steps taken by the docile-stock birds were made whilst slowly walking around the pen, frequently in the course of pecking the litter. On the basis of this qualitative difference in behaviour it would appear that the flighty-stock birds were more afraid of the strange pen than the docile-stock

birds were. A later experiment, C 9, compares the ambulatory activity of birds of the two stocks in a situation in which it is almost certainly exploration and not fear that is the motivating force.

The strange pen obviously aroused exploration as well as fear in the birds for they spent much time standing looking all around them, often with head and neck outstretched, and also frequently pecked at the wood shavings of the floor litter, a substance they had not previously experienced. Fixating and pecking have both been described as typical exploratory responses in the domestic fowl(Wunschman 1963, Horne and Wood-Gush 1970). Looking around, or fixating, proved impossible to measure accurately; but at both ages the time spent pecking was greater, although not significantly, in flighty-stock birds. Typically a flighty-stock bird would pace along the walls for a few minutes, then stand either looking around or pecking litter for a few minutes and then start pacing again. Such an alteration of responses was one of the reasons put forward in the Literature Review of this section for regarding fear and explorations as having separate motivations. Indeed the arousal of both fear and exploration seems particularly probable in a case such as the present one in which the stimulus had many novel aspects. Its size and emptiness might have aroused fear, expressed as pacing along the walls; the floor litter might have aroused exploration, resulting in pecking. Both of these novel aspects might have aroused a higher level of their respective motivational states in the flighty-stock birds than in those of the docile stock. Of course the litter pecking might not have been a purely exploratory response but a displacement activity arising as a result of the simultaneous presence of the conflicting tendencies to escape and to explore.

2. Why were the stock differences of a much greater magnitude in the 9-month old birds than in the 14-week old birds?

Rather than discarding the results of the younger birds because they did not quite reach what is after all only an arbitrary amount of numerical difference it seems more relevant to note that, both with regard to the quantified behaviour patterns and in the quality of their behaviour the stock differences in the younger birds were in the same direction as those of the mature birds. For this reason the stock differences in the younger birds may be more validly accepted as representing a reliable stock difference than would have been possible if only young birds had been observed. Statistical comparisons within each stock between mature and 14-week old birds were not made as it would have been impossible to tell which variable accounted for any differences found. The birds were not only of widely different ages but were at different stages of maturity, thus having different hormonal levels. They also had different home environments and any of these factors could affect birds' general levels of fearfulness or their fear of the particular strange environments used. If the birds were less afraid of strange environments at 14-weeks of age than as mature birds, then when placed in one which differed only very slightly from the home one either no or only minimal fear should be induced. This is done in experiment C 10.

Experiment C 8

Introduction and Object In experiment C 5 a stock difference in the responses of young chicks to a totally strange environment was observed. It was suggested that chicks which moved around, showed active attempts to escape and peeped were less afraid than those which stood or lay still, closed their eyes and were silent. In the present experiment an attempt was made to produce minimal fear in chicks by exposing them to a minimal amount of environmental change. This was done by removing a chick's companion, one of the environmental changes involved in experiment C 5, leaving other aspects of the environment unaltered. Chicks were observed at the same three ages as in experiment C 5 to discover if there were any corresponding differences in response with age.

Materials and Methods A total of thirty-six chicks of each stock were observed, twelve at each of 4, 7 and 14 days of age. They had been housed since hatching in pairs in standard chick-boxes.
When both chicks in a pair were asleep one of them was quietly removed without disturbing the other one. When the remaining chick awoke it was observed for a period of 5min, starting when it stood up, and a continuous record of all its activities made on a portable tape recorder. The experimenter was hidden from the chick's view and spoke very softly so as not to disturb it.

Chicks in their home boxes almost always walk from one side of the box to the other and then stop, rather than taking one or two steps, frequently backwards or round in a circle, as was typical of chicks observed in the sound-proof room. Thus in the present experiment, the number of times each chick walked across the box was counted rather than the total number of steps taken.

Results There was a striking difference in behaviour of chicks in this situation as compared to that shown by chicks in the sound-proof room in experiment C 5. In the present case the chicks, on the whole, responded much more actively, moving throughout the entire area of the box and showing more escape-directed activities such as jumping up at the walls or on and off the food jars. Although more than half the chicks spent some time with their eyes closed and a few also laid their beaks on the ground these were not part of the same abnormal behaviour patterns shown by chicks in the sound-proof room. In the present instance chicks always lay down first and then closed their eyes and rested their beaks on the ground in the "normal" sleep pattern. Peeping was a relatively common response, shown by thirty-seven of the seventy-two chicks. A total of twenty-six chicks defaecated.

There were no significant stock differences at all in any of the behaviour patterns observed either as regards the numbers of chicks performing them or the times and incidences of performance. There were however two age-related differences. The times spent peeping and time spent standing were less in older chicks than in the younger ones, $p < 0.05$ in both cases.
The data are presented in Tables C 13 A and C 14 A.

Discussion Jumping up at the walls and peeping are not usually shown by chicks on waking; thus their occurrence in the present situation indicated that the chicks had perceived and been upset by the disappearance of their companions. However the occurrence of normal sleep patterns, which were hardly ever shown in the sound-proof room and the absence of the abnormal sleep pattern, which was very common in the sound-proof room pointed to a relatively low level of emotional disturbance

or fear. Active escape attempts and peeping have both been associated with relatively low levels of fear (Hogan 1965).

If it may therefore be accepted that the chicks in this situation were experiencing low levels of fear it follows that there is evidence that at low levels of fear to environmental change chicks of the two stocks responded in the same way. This may then be used as support for the previously proposed theory that the different responses shown by chicks of the two stocks in the totally strange environment represented different levels of fear and that the lower level was expressed by active attempts to escape and by peeping. This argument has of course taken for granted that one may generalise from findings about fear evoked by one degree of environmental change to that evoked by another. The permissibility of such a generalisation must be borne in mind in considering the above argument.

It was interesting that during this 5min observation twenty-six of the seventy-two chicks defaecated whereas during the 15min observation in the totally strange environment only ten out of one hundred and sixty-eight chicks did so. Incidental observation on chicks in their home boxes showed defaecating was not a typical response on waking. Thus defaecation occurring at a greater incidence than would be expected in the undisturbed home situation may be indicative of a low state of fear. But obviously since the absence of defaecation may mean no fear at all, as in the undisturbed home situation, or a very high level of fear, as in the sound-proof room, its usefulness as a yardstick for measuring fear is limited.

The smaller amount of peeping shown by the older chicks as compared to the younger ones was somewhat unexpected. This was the same trend as was seen in the totally strange environment, experiment C 5, in which case it was suggested that the environmental changes involved had induced such a high state of fear in the older chicks that peeping was inhibited. Since in the present case there were no corresponding environmental changes it was presumed that there would be no corresponding inhibition of peeping and that the older chicks, which would presumably be more afraid at the loss of their companions, would peep more than the younger ones. However it appears that the degree of fear experienced by the older chicks was in fact sufficiently great to again inhibit peeping. Only one other study could be found which studied the effects on peeping of losing only social companions unconfounded by the loss of the familiar environment. Fullerton, Berryman and Sluckin (1970) found no difference in the amounts of peeping shown by 1-day old and by 4-day old chicks, this being very great at both ages. There is obviously a very delicate interaction between age and the amount of fear which must be experienced before peeping is (a) elicited and (b) inhibited and this must seriously restrict the usefulness of peeping as a tool for measuring levels of fear.

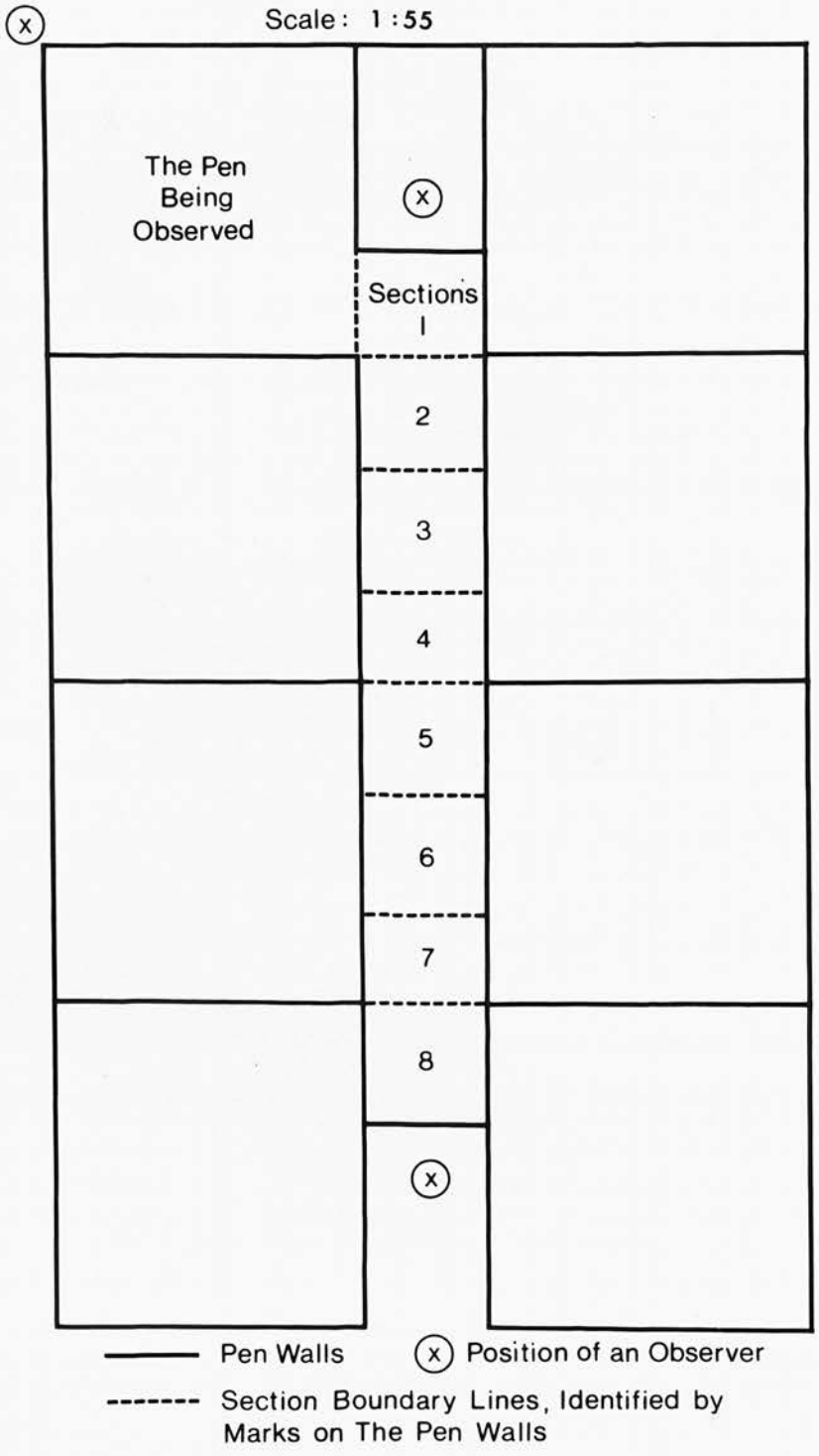
Experiment C 9

Introduction and Object In experiment C 6 mature, cage-housed birds were observed when isolated in a strange pen. The two stocks differed in their responses, the flighty-stock birds showing a greater amount of locomotion, on several different measures, than the docile-stock birds. On the basis of a comparison of the qualitative differences in the locomotion of the two stocks it was tentatively suggested that the greater amount of locomotion shown by the flighty-stock birds was as a result of their greater underlying state of fear. Locomotion in a strange environment has also been interpreted as an exploratory response occurring only in the absence of fear (Montgomery and Monkman 1955). It was proposed by Welker (1957, 1959) that locomotion could only be used to measure exploratory tendencies if it was certain that the animal was not in a state of fear. He proposed that this would only be so if the animal were able to enter and leave the strange environment at will from its home environment. If the animal experienced fear in the strange environment it would return to its home environment and would only move around and explore the strange surroundings if fear was absent.

Welker's method was used in the present experiment and the responses of mature birds of the two stocks compared when they were given free access to a strange environment adjoining the home one. If the greater amount of locomotion of the flighty-stock birds in the strange environment, from which they could not escape (experiment C 6) had in fact been motivated by their greater tendency to explore then the flighty-stock birds would possibly also show more exploration than the docile-stock birds in the present "free exploration" situation.

Figure C2

A plan of the experimental situation in which a pen of birds was given access to an area of corridor adjoining the home pen.



Subjects A total of thirty flighty-stock and twenty-seven docile-stock birds were observed at approximately 7 months of age. They were housed in pens as follows:-

Pen A - 10 flighty stock

Pen B - 9 docile stock

Pen C - 13 flighty stock

Pen D - 12 docile stock

Pen E - 7 flighty stock and 6 docile stock

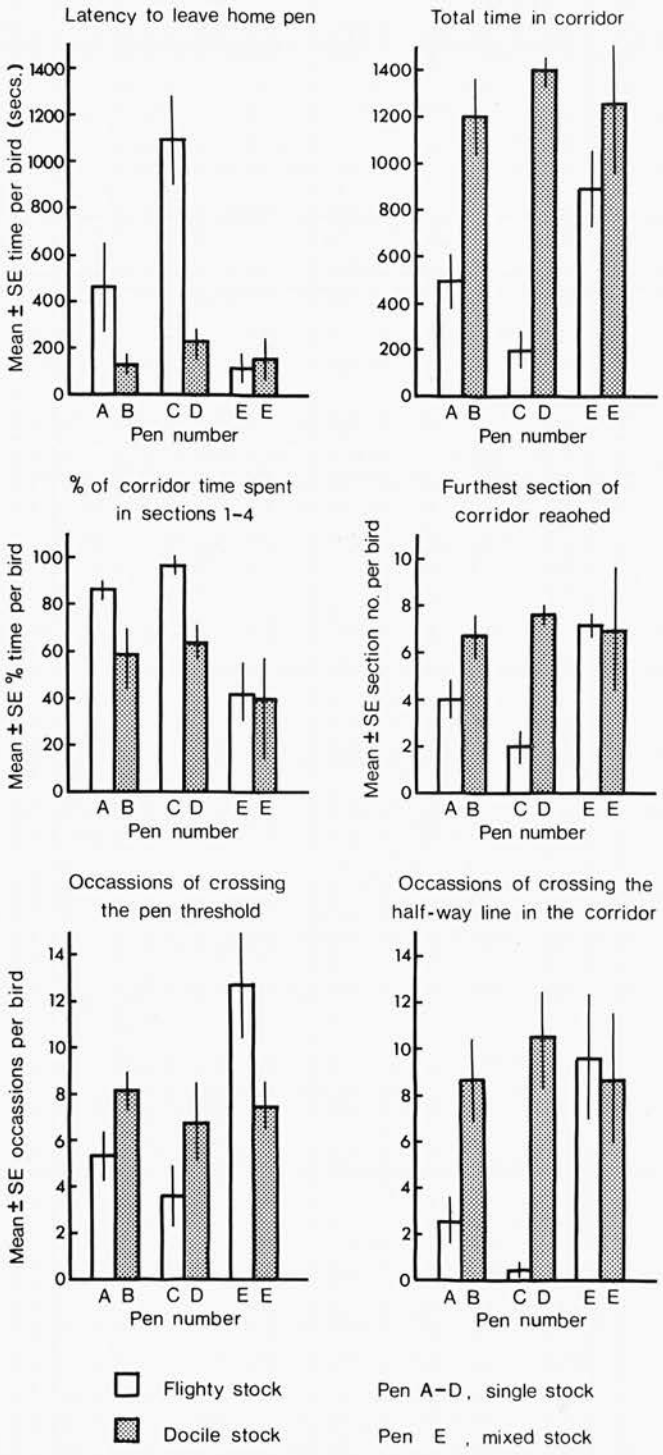
They had been in these pens for approximately 14 weeks at the time of the experiment and before this all had been reared in groups of their own stock.

Materials and Methods All of the above pens were situated at one end of a long corridor flanked by similar pens. When the door of the pen to be observed was opened it blocked off one end of the corridor. A similar door was used to close the other end, thus giving the birds in the pen free access to an area of corridor 6.5m long and 1.2m wide. The walls and floor of the corridor were of similar materials to the pen except that the concrete floor was not covered with wood shavings. The panels of the corridor wall were used as markers to divide the length of the corridor into eight equally-sized sections. Section 1 was immediately outside the pen door, section 8 being furthest from it. An observer stood behind each of the two end doors watching the four sections nearest to that door and a third observer watched the pen (see figure C 2).

The Experimental procedure was as follows. The pen door was opened giving the birds access to the corridor. They were then observed for 30min and the time at which each bird crossed a section boundary or entered or left the pen was noted by the appropriate observer. From the

Figure C3

A comparison of mature birds of the two stocks, housed either in single-stock or in mixed-stock pens, when they were given free access to an area of corridor adjoining the home pen.



combined observation records it was calculated how long each bird spent out of its pen and how far down the corridor it went.

Analysis Pen A (flighty stock) and Pen B (docile stock) were observed on consecutive days and the results compared. Pens C (flighty stock) and D (docile stock) were observed some months later and compared with each other. Pen E (mixed) was observed at the same time as Pens C and D and a between-stock comparison was made of the birds within this pen. Statistical analysis was by the Mann Whitney U-Test, 2-tailed.

Results The two sets of single-stock pens showed very similar results, see Figure C 3. The flighty-stock birds took longer to initially leave the home pen (A v. B $p < 0.02$, C v. D $p < 0.002$) and their total time spent in the corridor was much less than that of the docile-stock birds (A v. B $p < 0.02$, C v. D $p < 0.002$) there being no overlap at all in the latter time between pens C and D; the greatest time spent in the corridor by a flighty-stock bird was 652s and the least time for a docile-stock bird was 1075s. All of the docile-stock birds spent some time out in the corridor whereas seven of the thirty flighty-stock birds never entered it. Each of these seven did however stand at the pen threshold at least once looking out into the corridor. The flighty-stock birds did not venture as far down the corridor as the docile-stock birds (A v. B $p < 0.02$, C v. D $p < 0.002$). Only seven flighty-stock birds reached section 7 or 8 whereas twenty-four docile-stock birds did so. There were no stock differences in the number of occasions that birds crossed the pen threshold but the docile-stock birds crossed the half-way line down the corridor, the 4/5 line, more often (A v. B $p < 0.02$, C v. D $p < 0.002$). The flighty-stock birds spent a greater percentage of their time in the corridor in sections 1-4, those nearest the pen, than did the docile stock (A v. B $p < 0.02$, C v. D $p < 0.002$).

The results of the mixed pen showed an interesting difference. The stock differences were less marked since the flighty-stock birds showed almost as much exploration as those of the docile stock. In fact the only significant stock difference was in the number of occasions the pen threshold was crossed. The means $\pm$ SE were 12.9 $\pm$ 2.1 for the flighty-stock birds and 7.7 $\pm$ 0.9 for the docile-stock birds ($p < 0.05$).

There were no qualitative stock differences in the behaviour of the birds when in the corridor, they all mostly walked around rather slowly with an occasional burst of running. None of the birds ever paced up and down along the walls as birds enclosed in the strange pen had done. In fact they did little else apart from walking around and looking. They did not peck at the walls or the floor and none of them ever clucked or gave alarm calls.

Discussion Accepting that it was exploration which motivated the birds to leave their home pen and enter the strange corridor one particular aspect of their behaviour indicated that the corridor also aroused fear. This was the fact that all the birds tended to spend some time in the corridor, then return to the pen, then go back to the corridor and so on suggesting that they were in a state of conflict, being motivated both to enter and explore the corridor and to stay in the home pen because they were afraid of the corridor. If exploration had been the only motivating force present the birds should presumably have stayed in the corridor until their exploratory tendencies had subsided and should then have returned to, and stayed in the pen, for exploration is believed to decrease in strength with the amount of exposure to the stimulus object (Berlyne 1955).

It must now be decided whether the corridor evoked the same or different degrees of fear in birds of the two stocks. The results of the single-stock pens showed very clearly that the flighty-stock birds explored the corridor less than the docile-stock birds did on several different measures. Unfortunately there are at least two possible explanations for this. One is that the flighty-stock birds were more afraid of the corridor than were the docile-stock birds, but it is also possible that both stocks were equally afraid, or unafraid, of the corridor with the docile-stock birds having a greater tendency to explore it. In the mixed pen the flighty-stock birds showed as much exploration as the docile-stock ones. But this does not really help in deciding which, if either, stock was the more fearful for there are also at least two possible explanations for this greater exploration of the mixed-pen flighty-stock birds. One is that a supposed lower level of exploratory tendency in the flighty-stock birds was increased by the presence of the greater exploration of the docile-stock birds. The other is that a supposed higher level of fear in the flighty-stock birds was reduced by the absence of fear in the docile-stock birds. Such "social facilitation" effects are known to occur in the feeding behaviour of the domestic fowl (Guhl and Fischer 1969) and there seems no logical reason why they could not also exist in the fear and exploration systems in this species. The exploratory responses of one rat towards a novel object were found to increase as a result of exploratory responses being made by another rat (Simmel 1962) and the amount of fear, as measured by the duration of immobility of albino rats in an environment associated with pain was reduced by the presence of a non-fearful, and thus active rat (Davitz and Mason 1955).

However there was one factor in the behaviour of the mixed-pen flighty-stock birds which did help in comparing their levels of fear and of exploration with those of the docile-stock birds. This was the very great number of pen threshold crossings made by the mixed pen flighty-stock birds, see Figure C 3. It was argued above that birds left the corridor before their exploratory tendencies had completely subsided because once in the corridor they became afraid. If no such fear developed birds should stay in the corridor for a relatively long period and then return to the pen. This is in fact what the majority of docile-stock birds did, both in the single-stock and the mixed-stock pens. The single-stock flighty-stock birds also entered and left the pen on only a few occasions. However on each occasion they only remained in the corridor for a very short period and I suggest that this was because once in the corridor a large degree of fear developed causing them to return immediately to the home pen and to remain there for a relatively long time before venturing out again. In some of these birds the fear developed while they were standing at the pen threshold and they did not even enter the corridor once. Thus in the mixed pen it is probable that the fear of the flighty-stock birds, once they had returned to the pen, was quickly reduced by the sight of their docile-stock companions still in the corridor. They thus re-entered the corridor, but once in it their greater fear again developed causing them to return to the pen where the fear again quickly subsided and the whole process was continually repeated. In the single-stock pens there were never as many birds in the corridor at one time to provide this extra motivation for the flighty-stock birds to leave the pen and therefore they tended to do so less often.

How did the findings of this experiment relate to those of experiment C 6, in which birds were forcibly confined in a strange environment? The present experiment indicated that flighty-stock birds experienced greater fear than did docile-stock birds in a strange environment and that this greater fear of the flighty-stock birds successfully competed with exploratory tendencies. If it may be assumed that whichever stock was more afraid of a strange environment from which they could escape would also be the more afraid of one in which they were confined then, there is evidence that it was the flighty-stock birds which were more afraid in Experiment C 6 and that their greater locomotion in that experiment was in fact motivated by fear rather than by exploration. The two experiments taken together thus agree with Welker's (1957, 1959) findings with rats that locomotion in a strange environment from which there is no escape is more likely to be motivated by fear than by exploration; whereas locomotion in a strange environment from which the animal can escape into its home environment is more likely to be motivated by exploration than by fear.

It may be argued that comparisons cannot be made between the present experiment and experiment C 6 because in one case groups of birds were observed while in the other the birds were isolated from their social companions. This was done for the following reasons. The aim of experiment C 6 was to induce fear in the birds by exposing them to an environment which differed from the home environment. Isolating the birds from others was one of the fear-inducing components of the changed environment. In the present experiment the aim was to induce exploration in the birds with as little fear present as possible. If each bird had first been isolated in another pen it is highly probable that they would have been afraid of the empty pen as well as of the

corridor, and it might have been this fear of the pen rather than the tendency to explore the corridor which motivated the birds to enter and move around in the corridor. Any such potential ambiguity in the interpretation of the birds' behaviour had to be avoided, and the only way to be sure that birds were not afraid of the "home pen" was that it actually was the home pen. Obviously each bird's decision to enter and leave the home pen would not be entirely independent of the behaviour of the other birds although it is a common observation that domestic fowl are much less inclined to remain in a group when disturbed in any way than are other domestic species such as ducks or geese. However it was felt that any influences on each bird's exploratory behaviour by the action of other birds was of less importance than the effects of complete isolation would have been. More general aspects of comparing behaviour in different situations are discussed in the final section.

Experiment C 10

Introduction and Object In experiments C 1 and C 2 the responses of mature birds and of 14-week old birds to a totally strange environment were observed. No age-related differences in response were apparent, it being suggested that this was because all birds were responding with maximum fear. In experiments C 6 and C 7 the responses of birds of these same ages to an environment which differed from the home environment in all aspects except sound were observed. From the results it was very tentatively suggested that the younger birds were generally less fearful than the mature birds of this smaller amount of environmental change. If the amount of fear shown by the 14-week old birds varies directly with the amount of environmental change then a very slight change should perhaps evoke minimal or even no fear with no stock differences in response.

The present experiment investigates the responses of 14-week old birds to minimal environmental change. Since birds of this age were kept in large groups it was impracticable to change only their social environment, as was done with young chicks in experiment C 8, and therefore some aspects of the physical environment were changed. The responses of birds to a change in housing which is normally made at this age were observed. As well as contributing to the results of the present study the observation of and interpretation of the responses to such a procedure will be of general interest to those concerned with animal welfare.

Materials and Methods Sixteen birds of each stock were observed at 14 weeks of age. Before the experiment they were housed in communal rearing cages. The birds were transferred for observation to individual cages in the battery unit, several birds being moved and observed at one time. The changes in environment thus involved were partly visual, the battery cages overlooked pens whereas the rearing cages faced a wall; the sloping floor of the battery unit was also novel and the wire of the floor was of a different gauge to that of the rearing cage. The battery cages were much smaller than the rearing cages and each bird was caged individually in the battery unit. Otherwise the social environment was not changed; background noise was the same in both environments and both had food, in pellet form, available in open dishes outside the front of the cages.

Experimental procedure was as follows. Two birds of one stock were removed from the rearing cage and were placed together in a cardboard box, 45 x 25 x 20 cm high. Another two birds of the same stock were immediately placed in a second box. The boxes were then carried to the battery unit, a distance of about 5m, and the birds were removed from the

boxes and held upside-down by the legs. They were then placed in four adjoining battery cages, with at least six empty cages between these and the next occupied cages in the row. The birds were laid gently on the floor of the cages facing the back and with their legs stretched out behind them, which prevents the typical panic response, with the bird often flying out of the cage, which may occur if a bird is placed standing on a sloping floor for the first time. The experimenter then quickly secured the cages, went behind the wire mesh wall of a pen 1.5 m opposite the front of the cages and observed the four birds for a period of 30min. Four birds of the other stock were then similarly observed and, following a break of 1h, another four birds of each stock. One week later the entire procedure was repeated giving a total of sixteen birds of each stock.

Results Birds of the two stocks behaved very similarly when placed in the battery cages, see Table C 15 A. All birds had stood up within 10s of the start of observations and the greater part of the 30min was spent standing. Although the sloping floor obviously caused the birds some initial unsteadiness they all maintained a relaxed posture at all times. There was no freezing or crouching as had been shown by birds enclosed in the cardboard box in experiment C 6. About one half of the birds' mean time was spent facing out of the front of the cages; the mean time spent facing a neighbouring bird was higher in the docile stock, 524 $\pm$ 139s than in the flighty-stock, 189 $\pm$ 53s but this difference was not statistically significant. Birds of both stocks changed their direction of facing approximately eight times during the 30min observation period.

Preening and eating were the two most commonly occurring activities in terms of numbers of birds which performed them. Ten flighty-stock

and six docile-stock birds preened, the mean times involved being respectively 59.3 ± 22.3s and 68.4 ± 50.3s. The preening was not normal in appearance but was "hurried and incomplete" and eating would have been better described as "pecking at the food". Eight flighty-stock and fourteen docile-stock birds engaged in this activity the mean times involved being respectively 168 ± 49.4s and 202 ± 68.9s.

Almost half of the birds of each stock made escape movements with their heads at some time during the 30min. However no birds actually paced when in the cages and there were no clucks or alarm calls made. Only one bird defaecated; the incidence of comfort movements such as scratching or shaking were equally scarce. There was only one statistically significant stock difference in the birds' behaviour; while fourteen flighty-stock birds ate for a period of less than 5s only five docile-stock birds did so ($p < 0.01$).

Discussion The results appeared to confirm the suggestion that this slight degree of environmental change would induce only minimal fear and that there would be no stock difference in response. Evidence that birds were experiencing some degree of fear was as follows:- firstly, thirteen birds showed escape movements and although these are sometimes shown by birds undisturbed in their home cages the proportion of birds showing them during the short observation was far in excess of that which could not be expected in undisturbed conditions. Secondly neither preening, nor eating were normal but rather incomplete in their performance. This strongly suggests that neither was motivated by the relevant state but that they were displacement activities indicating the presence of conflicting tendencies, probably fear and

exploration. Preening of this appearance was in fact described by Duncan (1970) as "displacement preening", and since the birds had been on ad libitum feeding they should certainly not have been hungry at this time.

What evidence was there that the fear induced was only slight? There was certainly no pacing, freezing or alarm calling, but amongst birds isolated in a sound-proof area this was taken as indicative of a high level of fear. Apart from the apparently logical supposition that the present degree of environmental change must produce less fear than total isolation in a sound-proof area the qualitative differences in the birds' behaviour also suggested that the birds in the battery cages were not in a high state of fear. At all times they maintained a relaxed posture, never showing the tenseness of birds in the sound-proof area and this was despite the fact that the novel sloping floor was obviously causing some initial distress. Birds in the battery cages moved around more often and more confidently than those in the sound-proof area whose extreme caution and wariness at each step was very evident. It is emphasised that, in the absence of any available objective measurements the above suggestions about different levels of fear are suggestions only. If they may be accepted then, together with the results of experiments C 1 and C 2 and of C 6 and C 7 which are outlined in the introduction to this experiment, there is evidence that amongst 14-week old birds the amount of fear induced by a strange environment varies directly with the amount of environmental change involved.

Conclusions from experiments C 1-C 10

These ten experiments have investigated the responses of birds of the two stocks to strange environments. Birds of different ages have been observed and different amounts of environmental change have been involved in the different environments used. In some cases the bird was confined to the strange environment and in others it could escape from it at will. The main conclusion which may be drawn from the experiments is that the birds' responses, both in quality and quantity, were as varied as were the different environments and ages involved. There is obviously no simple or single way of determining how "generally fearful" or "emotional" a bird is from an observation of its behaviour in a strange environment. The fear shown by a bird in a strange environment was found to be affected by the following variables:-

1. Those stimulus components of the environment which were strange. This had a major effect on the quality of the fear responses shown. A silent environment was more likely to produce a lack of mobility and of vocalisation, at least in older birds, than was one with the accustomed level of background noise. A small, dark environment, the cardboard box, produced crouching and freezing, but a large and brightly lit one, the pen, produced pacing and vocalising in the same birds.

2. The age of the birds exposed to the strange environment. This was found to affect quality and possibly also quantity of fear responses produced. Older birds tended to stand silently in the sound-proof area whereas chicks, at least those of the docile-stock, tended to move about and to vocalise. Mature and 14-week old birds showed the same type of response to the strange pen, experiments C 6 and C 7, but there were quantitativedifferences which may have reflected different levels of fear.

3. The stock of the bird. In all cases, except older birds exposed to the sound-proof room, there were significant differences in the responses of birds of the two stocks to the various strange environments.

As well as independently influencing the type of fear response shown the above three factors all appeared to interact with one another. For instance in the sound-proof area there were no stock differences in response in birds of 6 weeks of age and above yet there were differences in chicks. It is therefore obvious that if individual or stock differences in the amount of fear present are to be detected then a suitable combination of strange environment and of age must be used. In other words, one that does not result in all the birds experiencing a very high or very low degree of fear and thus probably all behaving in the same way.

Bearing in mind the restrictions imposed by supposing that different degrees of environmental change will evoke different degrees of fear, the results of these ten experiments indicated that at all ages flighty-stock birds showed more fear of each of the strange environments used than did docile-stock birds. This greater fear appeared to cause the flighty-stock birds to show less locomotion than the docile-stock birds as chicks in the totally strange environment, as mature and 14-week old birds in the strange box, and as mature birds in the strange corridor. However it also appeared to cause them to show more locomotion than the docile-stock birds in the strange pen.

Another important finding from these experiments was that differences in underlying levels of fear motivation may (a) result in qualitatively rather than quantitatively different responses. Thus a high level of fear in chicks in a sound-proof environment appeared to be indicated by lying down and "sleeping" whereas a lower level seemed to be indicated

by pacing and jumping; and (b) when differences in fear level are expressed quantitatively they might not always be in the expected direction. For instance it is likely that the more a chick peeps in certain situations the less afraid it is.

The measurement of fear responses was found to be particularly difficult in those cases in which exploratory tendencies were also present and since the same types of stimulus situation frequently produce both motivational states this can be a major problem. Further confusion arises from the fact that exploratory and fearful responses may also be similar, such as walking around in a strange environment. If there is any possibility that an animal is being motivated by both states then particular attention should be given to the quality rather than the quantity of its behaviour, a proposal also made by Fraser D. (1974), for it is then usually quite easy to distinguish the two types of response.

2. The responses of birds to novel objects in the home environment

Introduction

The first ten experiments in this section described and discussed the responses of birds of the two stocks when they were exposed, either by force or by will, to a strange environment. The encountering of novel objects in the home environment is the other major type of novel stimulus situation to which animals are exposed in the wild. In the following experiments the responses of domestic fowls towards such novel objects are investigated.

Vision is the dominant sense in birds; thus only objects with novel visual aspects were used in these experiments. Although the sense of hearing is also fairly acute in domestic fowl it was not practically feasible to individually expose large numbers of birds to strange sounds while they were in their home environment. Three different age groups of birds were observed - mature birds, juveniles and chicks. It was found that age was an important variable in determining the responses of birds to strange environments and it has been proposed by various authors that immature animals show more exploration and less fear of strange objects than mature ones do (eg Hinde 1954, Hebb 1966).

At each age at least two different novel objects were used and one of these was always a novel source of food. Barnett (1955) found wild rats to be extremely wary of novel foods; they even refused to eat them for several days. Domestic rats showed no such wariness. It would be interesting to see how present-day domestic fowl would react to a novel food after generations of birds have been bred which have never either had to search for their food, or adapt to different foods.

Visual fixation of a novel object by a domestic fowl has been described as expressing a low level of exploration and pecking it as a higher level (Wunschmann 1963, Horne and Wood-Gush 1970). Fixating an object in the following experiments will be defined as staring at it with the beak pointing directly towards it and the neck outstretched.

Experiment C 11

Object To compare the responses of pen-housed birds of the two stocks when a variety of novel objects were placed in the home pen.

Introduction In a pilot experiment a single novel object, a red football, was placed in a pen containing a flock of twelve birds. The time spent by the birds in the area immediately surrounding it and also the number of fixations and pecks were recorded. While there was some statistical evidence from the results that the flighty-stock birds showed less avoidance of the red football than the docile-stock birds, actual exploration of it was generally lacking. It was obvious that social interactions as well as the sheer physical presence of other birds often interfered with a potential exploratory response and that a single novel object placed in the home pen was not a suitable way of arousing the birds' exploratory tendencies. In the present experiment attempts were made to overcome this difficulty by (a) exposing only two birds at a time to the novel objects and (b) exposing birds to a greater number and variety of objects and for a longer time.

It was of course possible that separating birds from their pen-mates would induce a state of fear, this being one reason why birds were not separated in experiment C 9. But since fearful and exploratory responses towards novel objects are more easily distinguishable from each

other than are the two types of response to a novel environment it was not as important in the present experiment to avoid inducing fear. It was much more important that exploratory responses in the limited space of the home environment were not interfered with by other birds. Few experiments can be designed exactly as one would wish - some sort of compromise has generally to be made.

Subjects Twelve birds of each stock were observed, housed normally in pens. The length of the experimental procedure made it impossible for laying hens to be used as their pre-nesting activity would probably have competed with their exploratory tendencies and invalidated the results. Birds were thus observed at approximately 5 months of age, just before they came into lay.

Materials The pen in which the observations were made was similar to the home pens. Seven objects, which varied in size, shape, colour, motility and, as was subsequently noticed by the birds, also in palatability were placed in the observation pen. These objects were:-

1. Football A standard-sized, red plastic football encased in a net of thin string and suspended 30 cm above the floor in the mid-point of the pen. The ball swung freely when touched.

2. Foam A piece of breeze block 44 x 22 x 6 cm high was covered with several layers of pink foam-rubber, carpet underlay to a depth of about 3 cm. The foam tore easily when pecked and appeared very palatable to the birds.

3. Frame This was a metal rod frame forming the edges of a cuboid with dimensions 40 x 55 x 55 cm high. The metal rod was 5 mm in diameter. From the top rod of each of the four sides was hung one of the following;

a. a blue nylon hand brush 32 cm long.

b. six plastic labels each 6 x 9 cm, brown on one side and pink on the other and loosely held together with paper clips.

c. Thirty-five plastic multicoloured leg rings threaded along a piece of string.

d. Five plastic multi-coloured margarine tubs threaded together on a piece of string.

All the above swung slightly if touched and birds could walk between them to stand in the centre of the frame.

4. Rubber Four pieces of red rubber tubing each 1 m long were tied together at the centre with string and hung from a hook on the wall of the pen.

5. Silver A bin 18 cm in diameter by 20 cm high was covered with silver foil and attached upside down by means of string to a piece of breeze block which held it steady. The foil tore off easily when pecked and was frequently swallowed by the birds.

6. Tunnel A cardboard box 50 x 25 x 27 cm high had both ends removed enabling birds to walk right through it, which they sometimes did.

7. Pouffe This was a blue plastic pouffe 50 cm by 50 cm by 25 cm high.

The floor of the pen was divided by means of the wall panels into nine squares of equal size. One square always contained the food hopper, and one always the water trough in the same positions as the home pen. The centre one always contained the football. The six remaining objects were placed one in each of the other six squares.

Methods The birds were observed in pairs and pairs were chosen which were close to each other in the peck order. A pair was taken from the home pen in the morning of day 1 and placed in the observation pen which

was empty except for food and water. They were then allowed two days in which to become accustomed to the loss of their pen mates.

On the morning of day 3 the objects were placed in the pen; this took about 90s. The birds were then observed from the corridor outside the pen for 3h and all their activities noted on a portable tape recorder. They were then returned to their home pen and the objects removed. On the following morning two birds of the other stock were placed in the observation pen and the procedure repeated with the objects in the same squares.

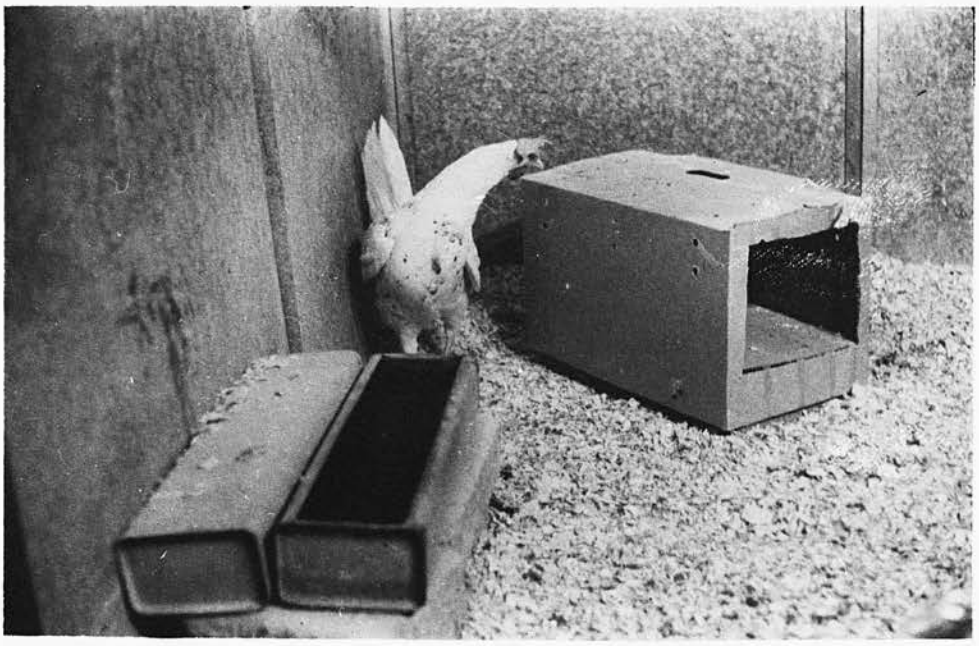
A total of six pairs of birds of each stock were observed. For each set of pairs the six objects were assigned to different squares as determined by a 6 x 6 Latin Square, to minimise any effects of preferred squares or objects.

Analysis The total time spent by each bird in each of the nine squares was calculated and also the total time spent in looking at, fixating and pecking objects. "Fixating" was distinguished from "looking" in that in the former case the bird's head and neck were outstretched towards the object. Times spent eating, drinking, preening, pecking litter and with eyes closed were also calculated and incidences of defaecations, comfort movements etc counted.

Results The birds showed no signs of fear in the way of pacing, jumping at the walls, clucking or alarm calling. They tended rather to avoid the objects by remaining in the corner beside the familiar food hopper; and this was particularly noticeable during the first 30min. During this time the flighty-stock birds entered a mean of only 5.1 ± 0.8 of the nine different squares and the docile-stock birds only 4.2 ± 0.4.

Plate 8

Some of the behaviour patterns shown by mature birds when several novel objects were placed in their pen.



A bird pecking at the cardboard tunnel.

A bird fixating the objects hanging from the metal frame.

Initial movements around the pen were made with obvious extreme caution, but by the end of the 3h period all birds were moving quite freely and normally, even brushing against the objects without startling as they had done at first.

Exploration of the objects both by fixating and pecking were common and are illustrated in Plate 8. Fixation always preceded the initial pecks made at each object. The bin covered with silver foil and the foam rubber proved extremely attractive to the birds, long periods being spent pecking them, resulting in the removal and ingestion of large quantities of them.

The flighty-stock birds spent longer (mean = 151 $\pm$ 47.2s) fixating objects than the docile-stock ones (mean = 14.5 $\pm$ 6.1s), $p < 0.002$; their mean pecking time was also greater although not significantly. Incidences of fixating and pecking were similarly higher in the flighty stock, the difference for fixating being significant at the 2% level. In both stocks all birds except one pecked an object at least once.

The docile-stock birds spent more time in the square with the water trough than did the flighty-stock ones ($p < 0.05$), apart from which there were no significant stock differences in the times spent in any particular square. In both stocks the least popular square, both in terms of the number of birds which entered it and in the mean time spent in it, was that with the pouffe. In the docile stock the greatest and in the flighty stock the second greatest mean time was spent in the square beside the food trough and twenty of the twenty-four birds spent some time eating. During the first 30min of the observation the docile-stock birds spent longer eating than those of the flighty stock, $p < 0.05$.

Figure C4

The behaviour of mature birds when several novel objects were placed in their pen for 3h.

The mean ± SE time spent in the area around each novel object and around the familiar food and water containers.

The upper number above each column shows the number of birds which fixated that object and the lower one shows the number which pecked it.

N = 12 birds in each stock.

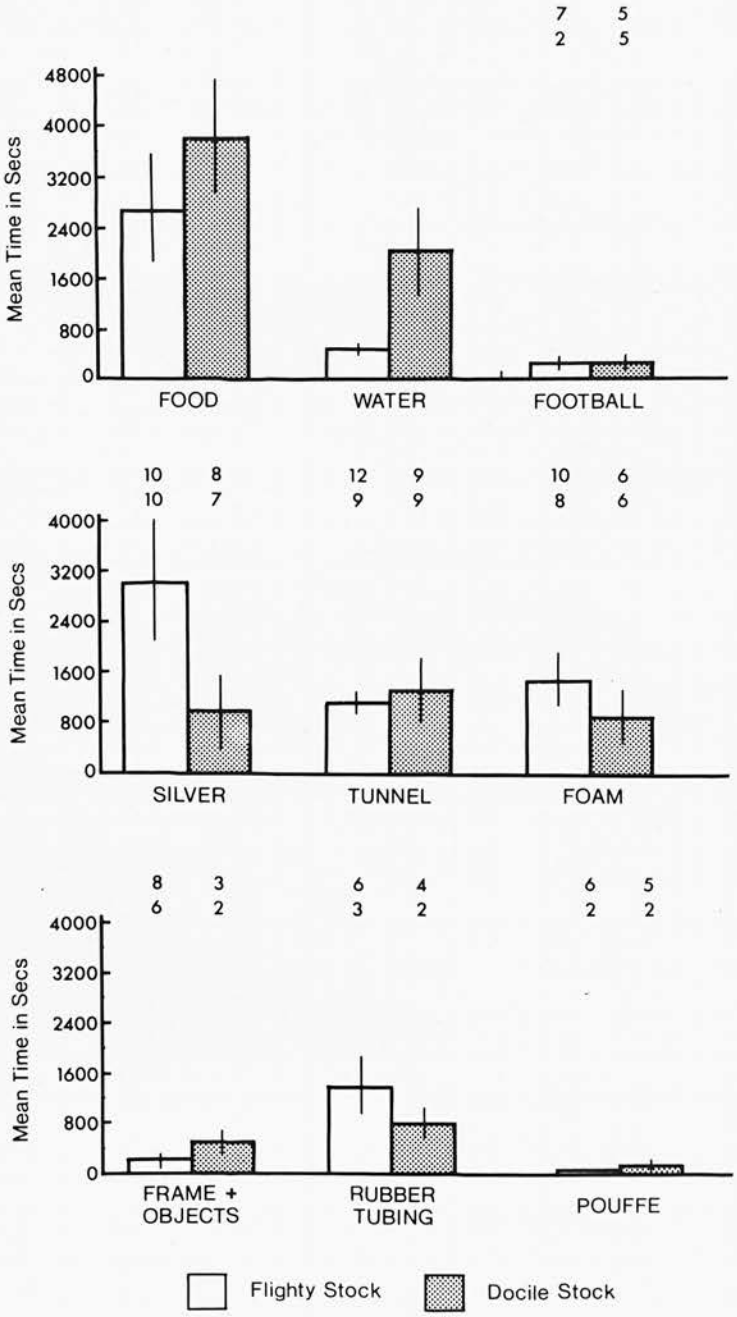


Figure C 4 shows the number of birds of each stock which fixated or pecked each object and also the mean time spent in each square.

In addition to exploring the objects all the birds spent some time preening or pecking the litter and all but two spent some time lying down; a total of six slept, showing the characteristic "head under wing" posture. There were no stock differences in any of these non-exploratory behaviour patterns.

The data are presented in Table C 16 A.

Discussion The methods employed in this experiment to increase the amount of exploration evoked appeared to succeed. Pairs of birds exposed to many strange objects for a long period showed more exploratory behaviour than many birds exposed to one strange object for a short period. However the birds were obviously also initially afraid when the strange objects were placed in the pen, for they kept as far away from them as possible and subsequent approaches were made with caution.

The different objects appeared to have different degrees of attractiveness to the birds. The cardboard tunnel, the bucket covered with tin foil and the foam rubber rated highly amongst both stocks in terms of numbers of birds fixating and pecking. This made it rather difficult to draw any conclusions about which properties of the objects elicited fixation and pecking; for there seems to be nothing in common between these three objects. The shiny foil might be expected to have elicited pecking, but why should the dull cardboard have done so? Much is known about the colour, shape and size of objects which will cause young chicks to approach them (eg Kovach 1971, Schulman, Hale and Graves 1970, Berryman, Fullerton and Sluckin 1971, Smith 1960, Smith and Hoyes 1961). Newly-hatched chicks prefer to peck at round rather than angular objects and at solid rather than flat ones (Fantz 1957). But nothing seems to be known about the stimuli which attract

older birds to approach and to explore. In the present experiment it was however relatively easy to determine what caused pecking to continue or not, once it had been initially elicited. Objects which tore easily, such as the silver foil and the foam rubber, and those which made a slight sound, such as the hollow tunnel, tended to be pecked again. Those which moved when pecked, like the football or the articles hanging from the frame, and those which neither tore nor resonated such as the pouffe tended not to be pecked again.

Did the two stocks differ in either the amounts of fear or of exploration evoked by the objects? There was some evidence that the docile-stock birds showed less exploration than the flighty-stock ones. Firstly the docile-stock birds spent more time than the flighty-stock birds in the squares containing the familiar food and water troughs. This may have been either because the docile-stock birds were more afraid of the objects than the flighty-stock birds were, or because they had a lesser tendency to explore the objects, assuming both stocks to be equally afraid (or unafraid) of them. Secondly the flighty-stock birds spent significantly more time and incidences fixating the objects than did the docile-stock birds. On this basis the flighty-stock birds may be said to have shown the greater level of exploration. The stock differences in pecking did not quite reach statistical significance although they were in the same direction as the differences in fixating. Again it cannot be known whether these differences in fixating and pecking resulted from basic differences in exploratory tendency or from differences in fear differentially inhibiting otherwise equal exploratory tendencies.

Experiment C 12

Object To compare the responses of mature battery-housed birds of the two stocks to a novel food.

Materials and Methods Nineteen battery-housed birds of each stock were observed at approximately 9 months of age. Their normal diet was proprietary layers' pellets, measuring approximately 1 cm in length and 0.5 cm in diameter and a dark brown-green colour. They were available ad libitum in individual food dishes slotted into a trough outside the front of the cages. Birds could not see into adjacent birds' food dishes.

The first requirement for this experiment was that all birds should be equally motivated to eat since only then could any differences in feeding behaviour be justifiably ascribed to differences in levels of fear or of exploration. A commonly used technique to standardise feeding motivation is to deprive animals of food for equal lengths of time. It is however known that the length of deprivation and the subsequent motivation to eat are (a) not linearly related and (b) do not show the same relationship with every measure of motivation that may be made (for review see Bolles 1967). The birds were trained to eat during a specific 5min period by removing the food for 2h before and 1h after it in the late afternoon of every day. By the 5th such day all birds were eating continuously during this 5min period between deprivations.

On the 6th day a detailed record was made of each bird's feeding activity during this 5min, the control observation. On the 7th day the novel food, chick mash dyed red, was given in place of the pellets and each bird's feeding activity again recorded. The novelty of the food was mainly in its colour, for since hatching the birds had

experienced only brownish food. The consistency and taste were not entirely novel as the birds had been fed on mash for approximately 9 weeks after hatching. Mash was chosen because it was known that all the birds would find it palatable and would not refuse to eat it on the grounds of taste.

All observations were made from behind the wire mesh wall of a pen 1.5 m in front of the battery unit. From the records the following measures of feeding activity were calculated:-

1. Latency to putting out head. After the food dish was returned the latency of each bird to put its head out between the front bars of the cage directly above the food dish.
2. Latency to 1st peck. After the food dish was returned the latency of each bird to peck at the food. Birds could see inside the food dishes without putting their heads out of the cages but they had to do so before they could peck.
3. Total time spent pecking food.
4. Total number of pecking bouts. Minimum bout length and also minimum inter-bout interval were both arbitrarily set at 5s.
5. Total number of individual pecks made. This included those made in bouts of more than 5s duration and also isolated pecks. Pecks were recorded on a hand tally counter; no distinction could be made between those that did and did not result in the ingestion of food.

Activities not directly concerned with feeding were also recorded including the time spent facing the front of the cage, time spent drinking and preening; incidences of pecking the environment and of performing comfort movements.

Analysis Any birds which did not either put their heads out of the cage or peck at the food were given latencies of 300s, the length of the observation period, for the purposes of statistical analysis. Comparisons between the two stocks for both the control and experimental observations were made with a Mann-Whitney U-test, 2-tailed. Within stock comparisons between the control and experimental observations were made using the Wilcoxon Matched-Pairs Signed-Ranks Test.

Results

a. Control Latencies to put head out of cage and to start pecking the food were very short in both stocks. With the exception of one flighty-stock bird all the birds had started to peck within 37s of the food dish being replaced; twenty-nine of the thirty-eight birds were pecking within 10s. The docile-stock birds made more pecks than the flighty-stock ones ($p < 0.05$); apart from which there were no significant stock differences.

The data are summarised in Table C 17 A.

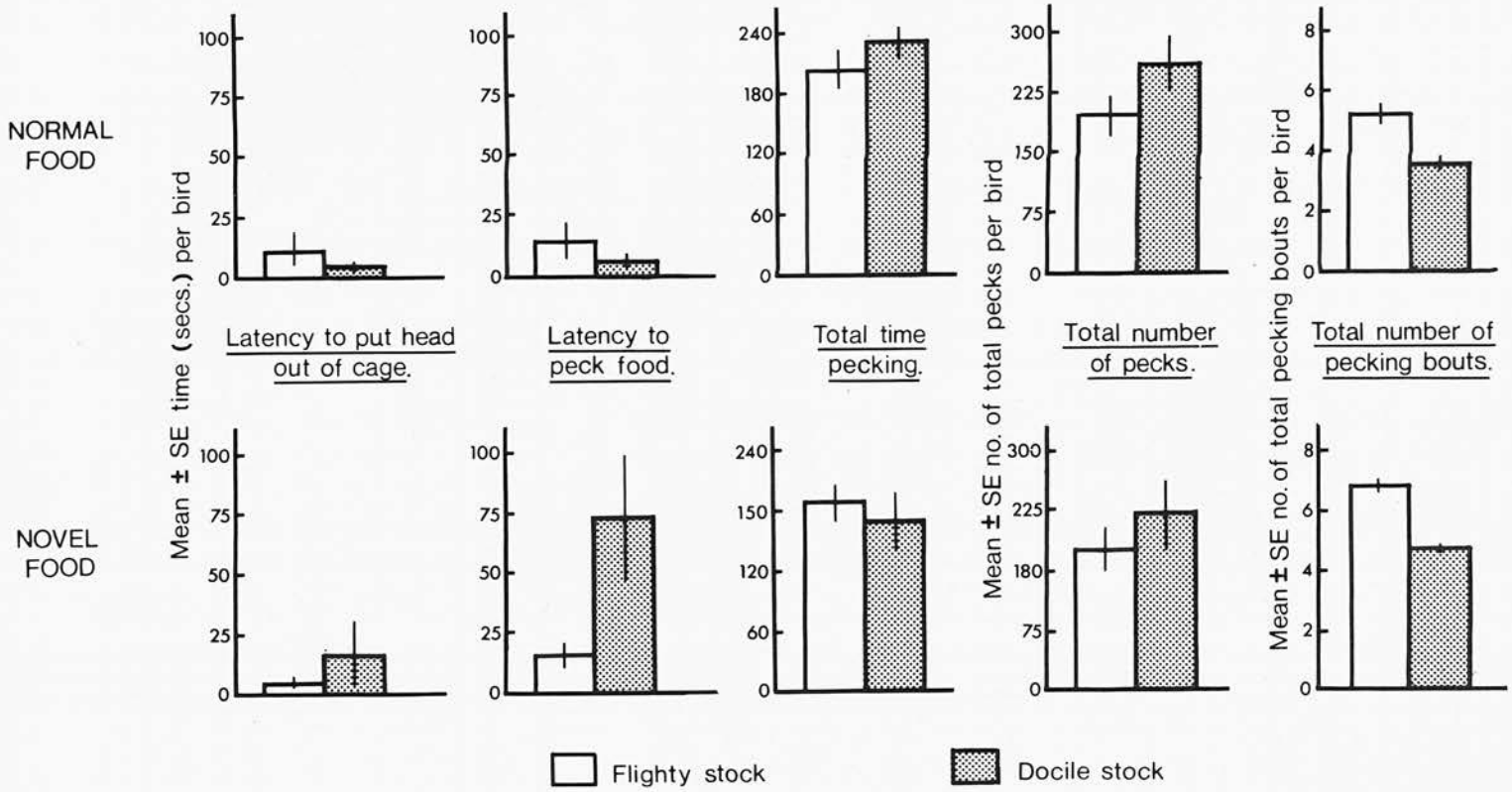
b. Experimental All the birds hesitated, at least momentarily, between putting their heads out of the cage and pecking the novel food; this was never done when the dish contained pellets. Many birds immediately withdrew their heads on seeing the red mash and then slowly edged them out again. Since most of the birds appeared not to notice the red food until they had put their heads out of the cage, these latencies were again very short.

Nineteen of the thirty-eight birds made their first peck within 10s of the food dish being replaced; but nine birds had latencies longer than 40s. Three docile-stock birds did not peck at all during the 5min and one of these did not even put her head out of the cage, although she stared at the food from the inside.

Exp C12

Figure C5

The behaviour of 9-month old birds given a) their normal food and b) a novel food for 300s following a 2h deprivation period.



There were no statistically significant differences between the two stocks either in the measures of feeding activity or in any of the other behaviour patterns.

The data are presented in Table C 17 A.

c. Comparison of control and experimental situations In neither stock was there any significant difference between control and experimental situations in the latency to put head out of cage. In the flighty stock there was also no difference in the latency to first peck; although in the docile stock this was longer in the experimental (mean = 73.7 $\pm$ 25.5s) than in the control (mean = 5.8 $\pm$ 1.9s) situation, $p < 0.05$.

Within both stocks the time spent pecking and the number of pecks made were less during the experimental situation. Time with head inside the cage and number of pecking bouts were greater during the experimental than the control situation in both stocks. However none of these differences were significant at the 5% level.

Figure C 5 illustrates the mean values for the five different measures of feeding activity made during both the control and experimental situations.

Discussion Changing the colour and consistency of the food did not cause any appreciable disruption of feeding behaviour in the flighty-stock birds. The docile-stock birds on the other hand did show more marked hesitation in eating it and it was only in this stock that latencies to first peck were significantly longer when there was novel food in the dish instead of the normal pellets. Several facts provided evidence that this greater hesitation of the docile-stock birds to peck the novel food was caused by their greater fear, or lesser tendency to explore it, and not by a lesser motivation to eat it:-

1. There was no stock difference in the latency to peck during the control situation.

2. During the control situation the docile-stock birds made significantly more pecks than the flighty-stock birds, and spent longer pecking, suggesting that, if anything, their motivation to eat was in fact greater.

3. In the experimental situation there were no stock differences in the number of pecks made or in the time spent eating, suggesting that the two stocks were in fact equally motivated to eat.

Thus the findings of this experiment were in agreement with that of the previous one, that mature docile-stock birds did not as readily explore novel objects placed in their home environment as did flighty-stock birds. These two experiments also demonstrated that the colour red in a novel object did not evoke aggression in the docile-stock birds of a sufficient intensity to successfully compete with their fear of the object; indeed no indications of even mild aggression were seen in any of the birds. Differences in levels of aggression evoked by the colour red therefore seem unlikely to have been responsible for the stock differences shown by birds to the novel and approaching red stimulus used in Section B.

As mentioned in the introduction to this experiment different measures of feeding and drinking motivation are not always linearly related to one another. Probably the best known example of this is Miller's (1956) study of the drinking behaviour of rats after salt solution had been pumped into their stomachs. The amount of water drunk, the amount of quinine in the water which was tolerated and the rate of bar-pressing to obtain water did not show parallel changes with each other. The only study of feeding motivation in the domestic fowl which could be found was that of Wood-Gush and Gower (1968) who used four different measures of feeding motivation after deprivation in adult male fowls. These were

the amount of food eaten, the rate of food comsumption, the rate of pecking and the strength of pecking. However they did not compare the results for each measure with each other, but rather how each changed with the length of deprivation period and with the type of food provided.

In the present experiment the five measures of feeding activity used correlated fairly well with each other in that they all changed in the expected direction when the novel food was presented - the latency to first peck became longer, the time spent pecking and the number of pecks made became less and the number of pecking bouts increased. The correlation between the measures was however not perfect for while the stocks differed significantly on one measure during the control situation, the number of pecks made, they did not do so on any of the other measures.

Experiment C 13

Object To compare the responses of 14-week old birds of the two stocks on their first exposure to the mechanical scraper in the battery unit.

Introduction A routine procedure in the poultry house is the cleaning of the droppings trays beneath the battery cages by a mechanical scraper. This is a complex stimulus involving changes in the birds' visual and auditory environments; the cages also vibrate slighty when the scraper is operating. In the brooder and rearing cages the trays were removed and cleaned by hand. Birds were first exposed to the mechanical scraper at approximately 14 weeks of age when they were transferred to the battery unit from the rearing cages.

It was difficult to decide where in the present study the responses of birds on their first exposure to the scraper ought to be reported. Although the scraper moved it did not "approach" the birds in the same sense that a human being or an inflating balloon did so and this experiment was therefore not included in Section B. Although it was a novel source of stimulation and was presented to the birds in their

home environment it was neither inanimate nor purely visual in its novelty as were all the other stimuli used in the experiments in this part of Section C. But it was felt that the responses of birds to this stimulus should be measured and described for it is one of the few "naturally-occurring" sources of novel stimulation to which commercially-kept laying birds are exposed in their otherwise mundane lives and is therefore of relevance to animal welfare studies.

Subjects A total of sixteen birds was observed at 14 weeks of age. On the previous day they had been moved to the battery unit from communal rearing cages. Since hatching the birds had been able to hear the scraper in daily operation.

Materials and Methods Fourteen cm below the wire floor of the battery cages was a glass strip where the birds' droppings collected. The metal scraper blade first passed above this strip without touching it, blade up, and was then returned along the length of the unit resting against the glass and pushing the droppings before it, blade down. In addition to the noise of the motor, heard both when the blades were up or down, the returning blade scratched loudly on the glass.

Experimental procedure was as follows:- The scraper was set in motion and passed beneath the cages with the blades up. The experimenter walked two cages behind it noting the reaction of each bird as the blade passed under its cage. Thirty seconds after the scraper had reached the end of the unit it was returned with the blades down, the experimenter again following and noting the birds' reactions.

Reactions were scored according to the following list of mutually

exclusive responses with score 9 representing the maximum and score 1 the minimum alarm shown.

9. Panic - bird dashed blindly around cage, squawking loudly.
8. Repeated jumping at cage walls.
7. A single jump at walls or into the air.
6. Clawing at the cage walls.
5. Making escape movements with head.
4. Placing one foot up on the rim of the food trough.
3. Taking one or two steps on the spot.
2. Standing still.
1. Looking down through the cage floor at the scraper.

The entire experiment was performed twice, half of the birds of each stock being observed at each occasion. One one occasion the flighty-stock birds were at the end of the unit nearest the scraper's resting point and on the other the docile-stock birds occupied these cages.

Results Birds of both stocks responded very similarly to the passing scraper. The majority were greatly alarmed, either panicking or jumping up at the cage walls. However a few birds of each stock appeared completely unperturbed. When the scraper passed with the blades up the mean score obtained by the flighty-stock birds was 6.8 ± 0.8 and for the docile-stock birds it was 6.7 ± 0.7. When the scraper passed with blades down the mean scores were 6.4 ± 0.7 for the flighty stock and 8.3 ± 0.4 for the docile stock ($p < 0.05$ Mann-Whitney U-Test, 2-tailed). Thus although the flighty-stock birds behaved very similarly whether the blades were up or down, more docile-stock birds panicked when the blades were down, N = 12, than did when they were up, N = 5.

The data are shown in Table C 18 A.

Discussion Since the birds had always been able to hear the scraper it was more probable that the alarm it caused was due to the birds seeing and/or feeling it for the first time. No method was available to me of comparing the level of vibration in the cages at these two times. The only visual differences in the two situations was that the returning blade was pushing the accumulated droppings before it. Although this was obviously a moving stimulus it was not approaching, in the sense that the human being or balloon was in the experiments described in Sections A and B in which it was found that the flighty-stock birds showed greater alarm, or withdrawal. This appears to emphasise the importance of the approaching aspect of a moving stimulus in eliciting withdrawal responses in the flighty-stock birds.

Hearing the scraper at close quarters instead of from a distance of 5 m, as they had previously done, may also have affected the two stocks differently. In particular the loud scratching sounds of the scraper with blade down may have alarmed the docile-stock birds. Unfortunately it was not possible to separate these various aspects of the stimulus situation. It can only be said that, in response to a novel stimulus, partly involving a moving but non-approaching object, the docile-stock birds showed a greater level of alarm, or fear, than did the flighty-stock birds.

Experiment C 14

Object To compare the responses of juvenile birds of the two stocks to a novel food.

Introduction As in the previous experiment the responses of birds to a "naturally occurring" source of novel stimulation were observed. In the present case it was the change from chick mash to pelleted food which was made when the birds were approximately 9 weeks of age. In an earlier experiment in this section, C 12, the responses of mature birds to food of an unusual colour were observed and it was found that the docile-stock birds were more hesitant to eat it than the flighty-stock birds.

Subjects Thirty birds of each stock were observed at 9 weeks of age. Individual accommodation for birds of this age was not available so they were housed in groups of five in solid-sided cages each measuring 50 x 60 x 53 cm high. The cages were in a pen close to the communal rearing cages from which the birds had been moved 5 days before the experiment began. Since hatching the birds had been fed only on chick mash.

Materials and Methods Food and water were normally available ad libitum in dishes which clipped onto the outside of the cage doors. Groups were never housed in adjacent cages, thus birds could not see the contents of other dishes. Experimental procedure was as described for experiment C 12, with an initial training period to accustom the birds to eat following a period of deprivation. On the fourth and fifth days of deprivation the experimenter stood 1 m back from the cages during the feeding period to enable the birds to become accustomed to her presence.

Control observations were made on the sixth day of deprivation the birds being fed on mash as usual; the experimental observations being made on the seventh day, the food dishes being filled with pellets. A 10min feeding period was allowed to enable all five birds in a cage adequate opportunity to eat. Although all five could eat together they rarely did so and there was a constant exchange of birds at the food dish.

Pilot studies showed that many birds refused to eat the pellets when they were first given. When this occurred during the experimental situation the dish was removed for a further 2h and then replaced for another 10min observation period. This process was repeated either until all five birds in a cage had eaten or until a total of four consecutive deprivation-observation periods had elapsed.

During the control situation only latencies to first peck were measured. The speed with which the birds began to eat and the number of birds in each cage prevented an accurate distinction of latency to head out and latency to first peck. During the experimental situation the movements of the birds were much slower and it was possible to distinguish the following for each bird:-

1. Latency to put head out at front of cage.
2. Latency to first peck at the food.
3. Latency to pecking continuously at the food. This was noticeably different to the first isolated and cautious pecks made.
4. Latency to eating continuously. This was noticeably different to pecking in that birds raised their heads slighty to swallow between pecks. Further, this task required some practice before the birds were proficient at it.

All the above latencies were calculated from the time the food dish was returned after the first deprivation period regardless of when a bird actually performed the activity; if it did not begin

to peck continuously until 2min 20s after the start of the third 10min observation period its latency was thus 22min 20s. Any bird which did not perform any of the above activities during the four 10min observations periods was given a latency of 40min for the purposes of statistical analysis.

The experiment was performed three times, on each occasion two groups of birds of each stock were observed. Each group was deprived at a different time of day so that only one group would be hungry while observations were being made. This prevented any possible influence of the vocalisations of one hungry group on the feeding behaviour of another group.

Results

a. Control Situation Twenty-five docile-stock and fifteen flighty-stock birds started to peck as soon as the food dish was returned ($\chi^2 = 6.07$, $p < 0.02$). The mean latencies to start pecking were 18.8 ± 5.4s for the flighty-stock birds and 7.2 ± 3.4s ($p < 0.001$ for those of the docile stock Mann-Whitney U-test, 2-tailed). All birds had started to peck within 150s of the food dish being returned. The total times spent pecking were not significantly different, the mean values being 489 ± 20.7s for the flighty-stock and 510 ± 19.0s for the docile-stock birds. All the birds ate during the 10min observation period and the occurrence of behaviour patterns other than eating were relatively rare.

b. Experimental Situation The birds reacted with great caution to the novel food, especially those of the docile stock. Even latencies to putting head out were high, the mean values being 127 ± 26.4s in the flighty stock and significantly longer in the docile stock, mean = 332 ± 69.6s ($p < 0.002$). Three docile-stock birds did not

put their heads out until the second 10min observation, though they all looked at the pellets from inside the cage during the first period. Latencies to first peck were also significantly greater for the docile-stock birds ($p < 0.001$); the mean values were 162 $\pm$ 29.5s, flighty stock, and 805 $\pm$ 127s, docile stock. Thus most of the flighty-stock birds made their first peck shortly after putting their heads out and all but one did so during the first observation. However in the docile stock only twelve birds made their first peck during the first observation, a further ten did so during the second period, five during the third and one during the fourth. Two docile-stock birds never pecked at all.

Even fewer docile-stock than flighty-stock birds were pecking continuously by the end of the first two observation periods. The numbers for the docile stock were, five at the first observation, eight during each of the second and third, three during the fourth observation and six birds never pecked continuously. In the flighty stock the corresponding numbers were twenty-nine during the first observation and one during the second. Obviously the latencies to pecking continuously were significantly greater for the docile-stock birds ($p < 0.001$).

All thirty flighty-stock birds were eventually eating pellets but only eleven of the docile-stock birds did so ($\chi^2 = 24.95$, $p < 0.001$). The numbers of birds starting to eat during each observation were:-

first observation	15 flighty stock	3 docile stock
second observation	13 flighty stock	5 docile stock
third observation	2 flighty stock	3 docile stock
fourth observation	0 flighty stock	1 docile stock

In all, three flighty-stock groups required only one 10min observation for all birds in the group to be eating continuously, two groups required two observations each and the sixth group required three. None of the docile-stock groups had all birds eating after one observation; in fact five of the groups had to be observed four times. In the sixth group all birds were eating by the end of the second observation.

Since it was only during the first 10min period that all the birds were observed, this was the only observation for which separate stock comparisons could be made. During it, all thirty flighty-stock and only twenty-two docile-stock birds put their heads out of the cage ($\chi^2 = 10.31$ p $\angle$ 0.01); twenty-nine flighty-stock and twelve docile-stock birds made an initial peck at the pellets ($\chi^2 = 19.71$, p $\angle$ 0.001); twenty-five flighty-stock and five docile-stock birds were pecking continuously ($\chi^2 = 24.06$, p $\angle$ 0.001); and nine flighty-stock and two docile-stock birds were eating continuously ($\chi^2 = 4.01$, p $\angle$ 0.05). While only four flighty-stock birds left the food dish completely and lay down at the back of the cage, sixteen docile-stock birds did so ($\chi^2 = 10.54$, p $\angle$ 0.01). Typically the docile-stock birds stood at the front of the cage fixating the pellets, then walked around the cage, then fixated again repeating this process a few times before finally lying down and completely ignoring the food dish for the remainder of the 10min period.

Discussion The results of this experiment showed that the docile-stock birds were very much less prepared to initially investigate the novel food than were the flighty-stock birds. Even after a total deprivation period of 8h 40min, two of them had not made a single peck and another four had only made occasional pecks. The results

of the control observation left no doubt that after food deprivation the docile-stock birds were as equally motivated to eat as were the flighty-stock birds. In fact docile-stock birds had shorter latencies to eating at that time than did the flighty-stock birds. The great reluctance of the docile-stock birds even to make an initial peck at the pellets is similar to the findings described by Barnett (1955) for wild rats. If even the food container but not the food itself was changed he found that wild rats would refuse to eat completely for one or more days. During this time the rats did not investigate the new container but avoided it completely.

But why were the docile-stock birds so slow to first peck the pellets? They were presented in the normal food dish, when the birds were hungry and expected to be fed. Although in a different form to the mash the pellets were of a similar colour. Motivation to peck them was thus presumably very high. It can only be assumed that an even greater underlying motivational state of fear, aroused by the strangeness of the pellets, prevented the pecking response. However the docile-stock birds showed no obvious signs of fear such as escape movements, pacing or clucking. As described above, their most common reaction to the situation was, after a period of approach-withdrawal from the food dish, to lie down at the back of the cage. This behaviour pattern may be described as a displacement activity, arising as a result of conflict between the feeding drive and fear drive. Its irrelevancy as a response to either of these drives justifies the use of this term (Hinde 1970). A much more common response to a frustrating or conflict situation given by domestic fowl is displacement preening (Duncan 1970), but this was never observed in the present situation.

Thus, while the presence of fear appeared to be the reason for the initial slowness of the docile-stock birds to pack the pellets it did not explain the relatively greater lengths of time they required between initial pecking and continuous pecking and between continuous pecking and eating. In both cases the transition times were much less for the flighty-stock birds. It was obvious from having observed the birds however, why the docile-stock birds required this extra time. As stated in the Materials and Methods section the birds had to practice actually manipulating the pellets in their beaks before they were able to swallow them. At first, the pellets were frequently dropped and fell through the wire floor onto the droppings tray below. Falling pellets engaged the attention of the docile-stock birds much more than they did that of the flighty-stock birds. Many of the former definitely soon gave the impression that they were "purposefully" dropping pellets through the floor and watching them roll along the tray. It must be stressed that no quantitative measures were made of this practice but I was certain that its occurrence contributed greatly to the smaller number of docile-stock birds which were finally eating pellets. It therefore seemed that in the docile-stock birds feeding was at first prevented by the presence of a high level of fear but that once this had subsided exploratory or "play" behaviour successfully competed with the feeding tendency.

Experiment C 15

Object and Introduction The responses of young chicks of the two stocks to a novel object placed in the home environment was compared. Age-related changes in response to a totally strange environment were shown by young chicks in experiment C 5. Since large numbers of chicks were available the same different ages of chick were observed in the present experiment.

Materials and Methods A total of thirty-six different chicks of each stock were observed, twelve at each of 4, 7 and 14 days of age. After hatching they were kept individually in standard chick boxes.

The novel object used was a plastic ball, 4 cm in diameter, coloured half blue and half red. The chicks had not previously seen either of these colours. For 2 days before making an observation the experimenter carried out the following procedure. She placed her hand, fist clenched, on the centre of the floor of the chick box and withdrew it after 5s. By this time any running or jumping by the flighty-stock chicks had ceased. Then she sat back and observed the chick for 5min. No records of the chicks' behaviour were made at this time the object being solely to allow the chicks to become accustomed to the experimenter's hand entering the box. On the third day the experimenter held the novel object in her hand and left it there lying in the box, red side uppermost, when she withdrew her hand. Each chick's immediate response on seeing the coloured ball and also its behaviour during the following 5min were recorded.

Analysis Initial responses on seeing the object could be classified either as panic, fixating the object with head orientated directly towards

Plate 9

Some of the behaviour patterns shown by chicks when a novel object (coloured ball) was placed in the home box. (During the actual experiment chicks were housed individually.)

One chick is fixating the object directly i.e. with both eyes; the other chick has jumped onto a water jar and is facing away from the object and towards the wall.

it, or fixating with head orientated sideways, that is with one eye only. The number of chicks responding in each of the three ways were analysed for stock and age differences using Cochran's (1954) method of combining the results of contingency tables.

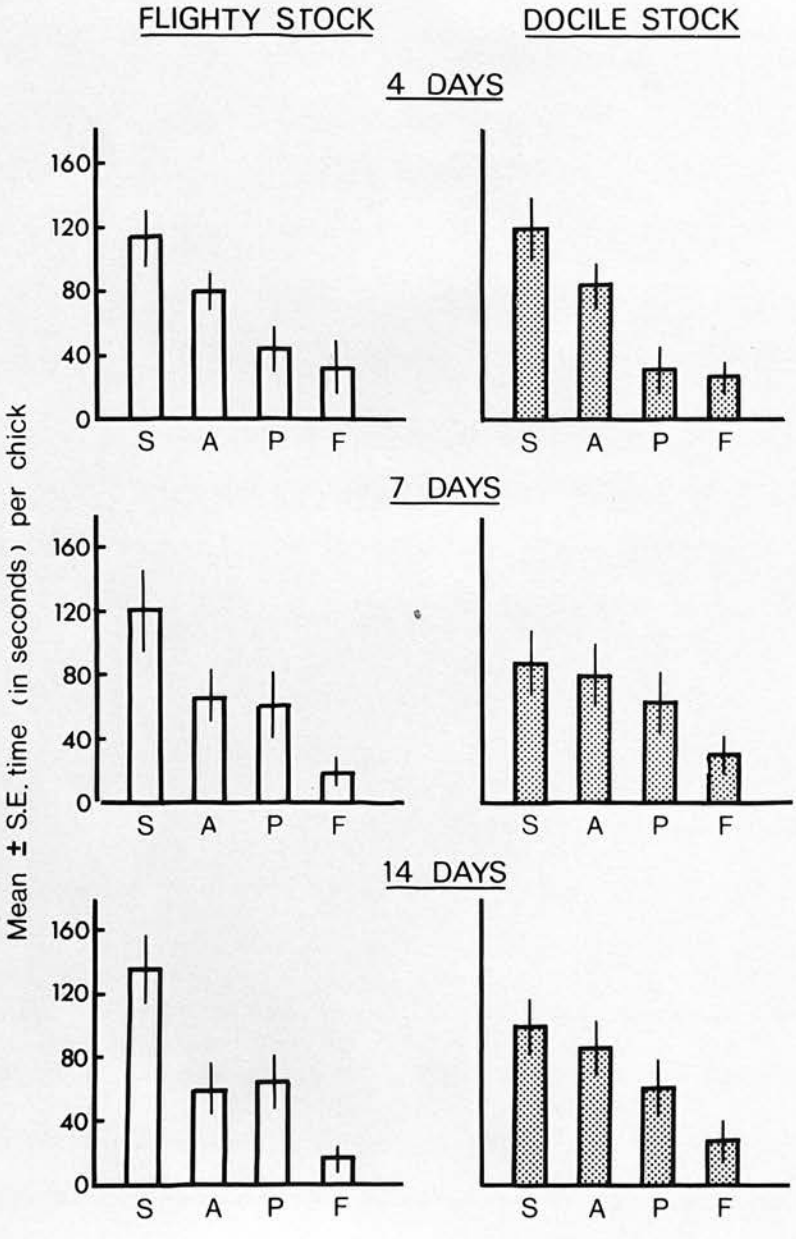
The total time spent by each chick during the 5min period standing still and fixating the object directly, fixating it side ways, or facing directly away from the object and towards the walls of the box were calculated. Some of these behaviour patterns are illustrated in Plate 9. Similar calculations were made for times spent eating, drinking, preening and walking around the box. If a chick walked from a side or corner of the box directly up to the object and then stopped in front of it, an "approach" was scored. The reverse process, moving backwards away from the object was scored as a "retreat". Numbers of approaches and retreats, as well as numbers of pecks at the object or the environment, jumps at wall, or on and off the food jar, defaecation and vocalisations were also counted and analysed.

Results

1. Initial Responses Twenty chicks panicked when the object was revealed, twenty-two fixated it directly and thirty fixated it sideways. There were significant stock and age differences in the relative frequencies of these responses. More docile-stock chicks fixated the object directly than did flighty-stock chicks ($p < 0.001$); more flighty-stock than docile-stock chicks fixated it sideways ($p < 0.01$). Panicking occurred more evenly between the stocks.
The number of chicks which panicked was greater in older chicks than in younger ($p < 0.01$) while the number fixating it directly was less in older chicks than in younger ones ($p < 0.01$). There were no significant age-related changes in the numbers fixating the object sideways.

Figure C6 Exp C15

The mean ± SE times (in seconds) that certain behaviour patterns were performed by chicks of each stock-age class when a novel object was placed in the home box.



S – Fixating object sideways P – Pacing at wall

A – Facing away from object F – Fixating object directly

The data for the initial responses are presented in Table C 19 A.

2. Behaviour during 5min period with novel object

a. Behaviour patterns performed as bouts of $>$ 5s duration

The analysis of variance detected no significant differences due either to age or stock in the times spent performing any of the behaviour patterns observed, whether or not they were concerned with the object. As Figure C 6 shows, in each of the six stock-age classes the greatest mean time of all was spent standing fixating the object sideways. Apart from the flighty-stock 14-day old chicks in which the second and third positions were reversed, the second greatest mean time was spent by all classes standing facing directly away from the object; the third greatest pacing to and fro along a wall of the box; and the fourth standing fixating the object directly. A total of twenty-three of the seventy-two chicks spent some time peeping; but eating, drinking, preening, litter scratching and eyes closed were all very uncommon in occurrence.

The data are given in Table C 20 A.

b. Behaviour patterns performed as incidences of $<$ 5s duration

The number of chicks approaching and the number retreating from the object were both less in older chicks than in younger ones ($p < 0.05$). More docile-stock chicks retreated from the object than did flighty-stock chicks ($p < 0.01$). More older chicks than younger ones jumped on and off the food jar ($p < 0.01$) and more younger chicks than older ones jumped up at the walls of the box ($p < 0.02$). However there was no significant age-related change when the two types of jumping were treated as one. A total of only six chicks actually pecked the object.

The data are given in Table C 21 A.

Discussion There were significant differences related to stock and others related to age in the initial responses of the chicks on seeing the object. Assuming panic to be the most fearful and fixating the object to be the least fearful of the responses shown, then more fear was shown by older chicks than by younger ones and more by flighty-stock chicks than by docile-stock ones.

During the 5min that the object was in the box the chicks behaved in ways that were obviously fear-motivated, pacing and jumping at the walls, and in ways that were obviously motivated by exploration, approaching, fixating and pecking the object. There was no gradual change-over during the 5min from fear responses to exploratory ones as might have been expected if the types of response resulted from a single underlying motivational state. Rather, chicks alternated between the two types of response suggesting two separate motivational states. Fixating the object sideways, the most common pattern in all six classes, may well have been an ambivalent posture indicating the simultaneous presence of tendencies both to approach and to withdraw. The occurrence of an ambivalent posture in a conflict situation has been reported as especially likely to occur when the two incompatible tendencies are elicited by the same object (Hinde 1970), as in the present case.

On balance the novel object seems to have elicited more fear than exploration since a greater number of birds performed behaviour patterns such as jumping, pacing, peeping and facing away, than pecked at the object or fixated it directly.

It remains to account for the lack of age and stock differences in response during the 5min that the object was present. The high incidence of obviously fear-motivated behaviour precludes the possibility that the

lack of differences in response was due to an overall lack or low level of fear being aroused in all chicks. That the opposite situation had occurred is possible, in other words that the object evoked a very high level of fear in all the chicks. Since however exploratory responses did alternate with the fear responses it appears most probable that the object was arousing an intermediate level of fear in all the chicks, and that this level was independent of stock or age.

Experiment C 16

Object and Introduction To compare the responses of chicks of the two stocks to a novel food. Since chicks would not have been able to eat food of any consistency other than mash, colour was chosen as the variable of the food which was changed.

Materials and Methods Twenty chicks of each stock were observed at 7 (control) and 8 (experimental) days of age. On hatching they were placed individually in standard chick-boxes. Food, in the form of light brown coloured mash, was normally available ad libitum in a perspex dish 14 x 6 x 8 cm high, placed in one back corner of the box. Chicks always stood inside these dishes when eating. A water jar stood in the other back corner of the box.

Training the chicks to eat after deprivation began on the 4th day after hatching, the deprivation period being 2h and the feeding period 5min. On the 5th and 6th day after hatching the experimenter remained beside the box while the chicks were feeding but no observations were taken. On the 7th day control observations were made, the chicks being fed the normal mash. On the 8th day mash which had been dyed red was given. The chicks had not previously been exposed to this colour.

From the observation records several measures were calculated for each chick, including the following:-

1. Total time spent at dish. The sum of the times spent in, perched on the rim of, or standing directly beside the dish regardless of whether or not the chick was eating.

2. Total time at water jar. The sum of the times spent perched on the rim of, or standing directly beside the water jar regardless of whether or not the chick was drinking.

3. Total time at front of box. The sum of the times spent in the front one-third of the box, as defined by markers on the walls. This was the part of the box farthest from the food dish.

The above three times did not account for the entire observation period since a chick could also be in the central area of the box or at the back between the food and water containers.

4. After the dish was returned, the latencies to jump inside the dish and to start eating were measured.

Times spent in behaviour patterns not directly concerned with eating such as pecking the floor litter, preening and eyes closed were calculated.

Analysis Statistical comparisons between the two stocks for both the control and the experimental situations were made with a Mann-Whitney U-test, 2-tailed. Within-stock comparisons of the two feeding situations were made with a Wilcoxon Matched-Pairs Signed-Ranks Test. Chicks which did not perform any particular behaviour pattern were given a latency of 5min for the purposes of statistical analysis.

Results

a. Control Flighty-stock chicks had longer latencies to start eating than docile-stock ones ($p < 0.05$). Apart from this there were no

significant stock differences in behaviour. Most of the 300s period was spent "at the food dish" and all of the chicks except two of each stock ate; the mean times being 206 ± 22.5s (flighty stock) and 233 ± 22.9s (docile stock). Only seven flighty-stock and four docile-stock chicks spent any time in the front area of the box; the occurrence of other non-feeding behaviour patterns was equally rare.

The data are presented in Table C 22 A.

b. Experimental The chicks were very hesitant to approach and eat the coloured food, especially those of the docile stock. Only twelve flighty-stock and six docile-stock chicks actually jumped into the dish and of these only six and four respectively ever pecked at the mash. All the pecking resulted in eating. The flighty-stock chicks spent longer "at the food dish", mean = 94.4 ± 25.7s than those of the docile stock, mean = 19.6 ± 7.6s ($p < 0.02$). Five flighty-stock and eleven docile-stock chicks approached the dish when it was returned but moved away immediately on seeing the coloured mash. Sometimes they repeated this pattern at a later stage of the observation, but since they never actually stopped and stood still beside the dish their "at dish" times were scored as zero.

All the docile-stock chicks and fourteen flighty-stock chicks spent some time at the front of the box away from the food dish, docile-stock chicks spending longer here than those of the flighty-stock ($p < 0.02$). A total of eleven chicks pecked litter, seven preened and nine had eyes closed.

The data are given in Table C 23 A.

c. Comparison of control and experimental situations Within both stocks there were significant differences in the behaviour of the chicks

in the two feeding situations. Docile-stock chicks had longer latencies to enter the dish when it contained red mash as opposed to ordinary mash ($p < 0.01$). In both stocks the latency to eat was longer with red mash ($p < 0.01$). Chicks spent less time "at the food dish" with red mash (flighty stock $p < 0.05$, docile stock $p < 0.01$) and less time "in the food dish" with red mash (both stocks $p < 0.01$). Docile-stock chicks spent longer at the water dish with red mash ($p < 0.01$); chicks of both stocks spent longer at the front end of the box with red mash ($p < 0.01$).

Discussion The results indicated that the docile-stock chicks were not as willing to explore the novel food as were those of the flighty stock. Indeed the general pattern of the docile-stock chicks' responses was very similar to that of the 9-week old birds of the same stock in experiment C 14. Amongst the chicks of the present experiment exploration of the novel food was even less common since chicks never fixated this new food in the way that the 9-week old birds had done. (Chicks of this age could fixate, they had done so in the previous experiment). The chicks merely glanced at the novel food and then retreated to the opposite end of the box. Having left the food the chicks did not lie down, as the 9-week old birds had tended to do, but instead pecked at floor litter or preened, probably displacement activities arising from the presence of the conflicting tendencies of hunger and fear. Additional evidence that the chicks were in a state of fear at this time comes from the observation that one flighty-stock and two docile-stock chicks rested their beaks on the ground while standing. This behaviour pattern was also observed in chicks isolated in a sound-proof area and hence presumably in a state of fear. I have never previously observed it in chicks in their home boxes. Therefore, although the numbers involved here were very small, I felt they were extremely significant.

Conclusions from experiments C 11-C 16

These six experiments have investigated the responses of birds of the two stocks to novel objects placed in the home environment. Birds of different ages have been observed and in each age range responses to a novel source of food as well as to another novel object were observed. Taking all the experiments as a whole it must be concluded that the flighty-stock birds showed more exploration of the novel objects than did the docile-stock birds. This statement must immediately be qualified by saying that "more exploration" may have been expressed either as more actual exploration in terms of fixating and pecking the objects or in terms of less avoidance and presumably less fear of the object. It is probably impossible to clearly distinguish between the fear- and exploration-evoking components of a novel stimulus and therefore impossible to state that differences in exploratory responses reflected differences only in exploratory tendencies. Stock differences in the amount of fear evoked by the stimulus may have influenced otherwise equal exploratory tendencies.

The greatest difference between the two stocks undoubtedly occurred when a novel source of food was involved. At 9 weeks of age and as chicks the docile-stock birds showed the same type of extreme reluctance to investigate a novel food that Barnett (1955) described for wild rats. However this stock difference was not so great in the mature birds, since almost all of the docile-stock birds did eat the novel food. While bearing in mind that caution must always be exercised in comparing the behaviour of birds of widely different ages, it does seem probable that the extent of the novelty of the different foods used was involved in determining the extent of the exploration of them by docile-stock birds. For the mature birds neither the colour, nor the consistency of the food

were absolutely novel (in Berlyne's 1960 sense); in other words the birds had seen the colour red before and they had eaten mash, but they had never seen red mash before. At 9 weeks of age the consistency of the food was absolutely novel, the birds had no previous experience of small hard objects which they could pick up in their beaks; and since the chicks had never seen the colour red before one aspect of their food was also absolutely novel. Even if it had been the same aspect of the food which had been made novel for all ages direct comparison between the different ages would not have been possible. Birds of the different ages obviously had different amounts of experience with their normal food and this could well be expected to affect the extent of the strange foods' novelty. It is therefore perhaps surprising that chicks which only had a few days experience of their normal food were so reluctant to explore a novel one whereas mature birds which had several months experience of their normal food showed very little hesitation in eating a novel one. Blanket statements to the effect that young animals are more curious than older ones are obviously not valid.

There was a very striking difference in the behaviour of the chicks presented with novel food and chicks presented with a novel object. In the latter case fear was expressed as panic, pacing or jumping at the walls, and peeping. With the novel food these behaviour patterns were never shown although the chicks' level of fear was high enough to inhibit eating after deprivation and to cause the "standing with beak on ground" posture. The two novel stimulus situations did not differ in any major respects. In both cases the stimuli were stationary and in both cases their novelty was mainly in their colour. It therefore appears most probable that the two types of fear responses represented two different levels of underlying fear motivation rather than the same

level expressed in two different ways as responses to two different types of stimulus situation. If this is indeed the case the inevitable question arises - which of the two response types represented the greater level of fear? The following evidence suggests that it was the novel food which evoked the greater fear.

1. Exploratory responses, such as fixating and pecking were more common with the coloured ball than the coloured food. The presence of a high level of fear is known to inhibit exploration.

2. The "standing with beak resting on the ground" posture occurred only with novel food. In response to a totally strange environment this behaviour pattern was believed to represent a higher level of fear than active escape movements.

3. Hebb (1953) provided good evidence that a familiar object, some aspect of which is made unfamiliar is a particularly powerful fear-producing stimulus, often more so than is a totally unfamiliar object. On this basis it would be expected that the familiar food dyed an unfamiliar colour would evoke more fear than the totally unfamiliar coloured ball.

If the above evidence is acceptable it again demonstrates the difficulty of recognising the presence of fear merely from observing the birds' behaviour. On first sight a chick pacing and peeping in the presence of a novel object would obviously be thought more fearful than one quietly pecking litter in the presence of a dish containing novel food. However a detailed analysis of these situations and a comparison with behaviour in other types of situations indicate that the reverse may in fact, have been true.

General conclusions from Section C

1. When birds of any age were isolated in a strange environment from which there was no means of escape fearful behaviour tended to predominate. But if birds were allowed free access to a strange environment or if a strange object was placed in the home environment then exploratory behaviour tended to be more prevalent. A little thought makes it obvious that such responses are what would be expected to occur under natural conditions to ensure a bird's maximum chance of survival.

2. With any type of strange stimulus, fearful and exploratory responses were found to alternate rather than to gradually change from one to the other. This finding supported the view that the two types of response have different underlying motivations. Although the same stimulus object may evoke both tendencies it is probable that they are evoked by different physical aspects of it; and the strength with which each is evoked probably changes differently with time of exposure to the stimulus.

3. In the domestic fowl certain behaviour patterns were unmistakeably recognisable as evoked by fear e.g. pacing and jumping at the walls or panicking and others such as fixating and pecking were obviously evoked by exploration. Some behaviour patterns, such as walking around, might have been evoked by either tendency; still others, including eating, preening, lying and eyes closed, which normally did not indicate the presence of fear, could do so when they were performed as displacement activities caused by conflict between fear and another tendency such as exploration or hunger. Exploratory responses were found to be much less variable either with age, with stock or with evoking stimulus than were fearful responses.

4. It was generally true that the flighty-stock birds were more afraid than those of the docile stock when in a strange environment, but that the flighty-stock birds showed more exploration of novel objects placed in the home environment than did those of the docile stock. However there were also cases in which there was no stock difference in response and others in which the difference was in the opposite direction. Fear and exploration are obviously no more "unitary drives" than are hunger, sex and aggression.

S E C T I O N D

Introduction

The experiments of the previous sections have shown that the persistence throughout life of withdrawal responses to human beings amongst birds of the flighty stock is one of the main ways in which the behaviour of birds of this stock is different to that of birds of the docile stock. It has been demonstrated that birds of the flighty stock show this greater level of withdrawal soon after hatching and that while withdrawal responses in the docile stock habituate completely by the time the birds reach maturity, those of the flighty stock habituate only very slightly. In this section experiments are described in which two different attempts were made to modify the responses of birds of the two stocks to human beings.

Experiments D 1 and D 2

Introduction Experiment D 1 is concerned with mature birds and D 2 with chicks during the first week of life. The aims of both experiments were to determine if the withdrawal responses of the flighty-stock birds towards human beings could be lessened in their intensity by the formation of an association between being handled by a human being and being fed.

Experiment D 1

Introduction

In this experiment it was also intended to determine if the responses of mature docile-stock birds towards human beings could be lessened in their intensity by the formation of an association between being handled and being exposed to a presumably non-rewarding situation.

Materials and Methods Twenty flighty-stock and nineteen docile-stock birds were observed at 7 months of age. They were housed in the centre row of the battery unit where food, in pellet form, was available ad libitum.

The birds of each stock were divided at random into two groups - a non-hungry group and a deprived group. Each group consisted of ten birds except the docile-stock deprived group in which there were only nine birds (one bird died suddenly late on during the experiment and a replacement was not available). Each week two or three birds of each stock were observed including at least one from each group. At the start of each week the birds to be observed were transferred to cages in the lower row of the battery unit and here the adjacent cages to each bird were always empty. The order in which the birds were observed was arranged such that birds which had not yet been observed were never left with two adjacent empty cages.

The birds were allowed 24h to adapt to this slight change in their surroundings, after which the food dishes of the deprived birds were removed. After a further 24h each bird was taken in turn to the experimental cage in the sound-proof room - see page 4 for description. It was left here alone for 15min, then was returned to its cage in the lower row of the battery unit. A dish containing pellets and also a dish of water were available, attached to the inside of the front of the experimental cage, for birds of the deprived group but not for those of the non-hungry group. Thus while the environment would be in itself equally upsetting to birds of both groups, the presence of food would make it a rewarding situation for the deprived birds. The observations on the non-hungry birds would also prevent the interpretation of any behavioural changes occurring as a result of adaptation to the sound-proof environment itself as changes occurring as a result of the

association of handling and feeding. It was known from experiment C 1 that mature birds of both stocks behaved very similarly on first isolation in the experimental cage.

Each bird was taken to the experimental cage on six successive days, after which it was returned to its original cage in the centre row of the battery unit. For each weekly group the order in which the birds were observed each day was determined by a 6 x 6 Latin Square or a 6 x 5 Randomised Block. Birds were carried between cages supported with one hand beneath the body, the head being covered with the experimenter's overall. They remained relaxed and still when thus carried.

Having placed a bird in the experimental cage the experimenter stood back and remained for 1min before leaving the room. If a deprived bird began to eat during this time, this latency to eat was noted. If it did not eat a latency of 60s was used for the purposes of statistical analysis. The amount of food eaten by each deprived bird each day was measured. Latencies to eat and amount eaten were compared between stocks with a Mann-Whitney U-test, 2-tailed.

The behaviour of each bird was noted on each day as it was being removed from the battery unit and as it was later being removed from the experimental cage. In particular each bird's response at each of the following stages was noted:-

Stage 1 Experimenter stands in front of cage

When the Experimenter crouched down in front of the battery cage

or/

When the Experimenter opened the door of the sound-proof room and stood in front of the experimental cage.

Table D 1

SCORE	STAGE 1 AT CAGE	STAGE 2 HAND ON CAGE	STAGE 3 CAGE OPEN	STAGE 4 REACH FOR BIRD
1	H O F	Pecks hand	Steps out	Pecks hand
2	H M or claws at cage front	H O F	H O F	↳ front of cage & faces E
3	↳ front of cage & faces E	H M or claws at cage front	↳ front of cage & faces E	↳ back of cage & faces E
4	↳ back of cage & faces E	↳ front of cage & faces E	↳ back of cage & faces E	↳ back of cage & faces S
5	↳ back of cage & faces S	↳ back of cage & faces E	↳ back of cage & faces S	↳ back of cage & faces B
6	↳ back of cage & faces B	↳ back of cage & faces S	↳ back of cage & faces B	H M or claws at cage back
7	HM or claws at cage back	↳ back of cage & faces B	H M or claws at cage back	Runs to & paces at cage back
8	Runs to & paces at cage back	H M or claws at cage back	Runs to & paces at cage back	Jumps up at back of cage
9	Jumps up at back of cage	Runs to & paces at cage back	Jumps up at back of cage	Panic
10	Panic	Jumps up at back of cage	Panic	-
11	-	Panic	-	-

H O F = Head out between front bars of cage; or across threshold if cage was open.

H M = Stereotyped, circular movements of the head at the bars of the cage.

↳ = Walks to or stays at - - -

faces E = faces the Experimenter directly

faces S = stands sideways on to the Experimenter

faces B = faces the back of the cage, i.e. away from the Experimenter

Stage 2 Experimenter places hands on cage

The Experimenter placed both hands on the front of the cage.

Stage 3 Experimenter opens the cage

The Experimenter opened the cage door.

Stage 4 Experimenter reaches for bird

The Experimenter reached into the cage towards the bird with both hands.

Stage 5 Experimenter picks up the bird

The bird was picked up with both hands from underneath.

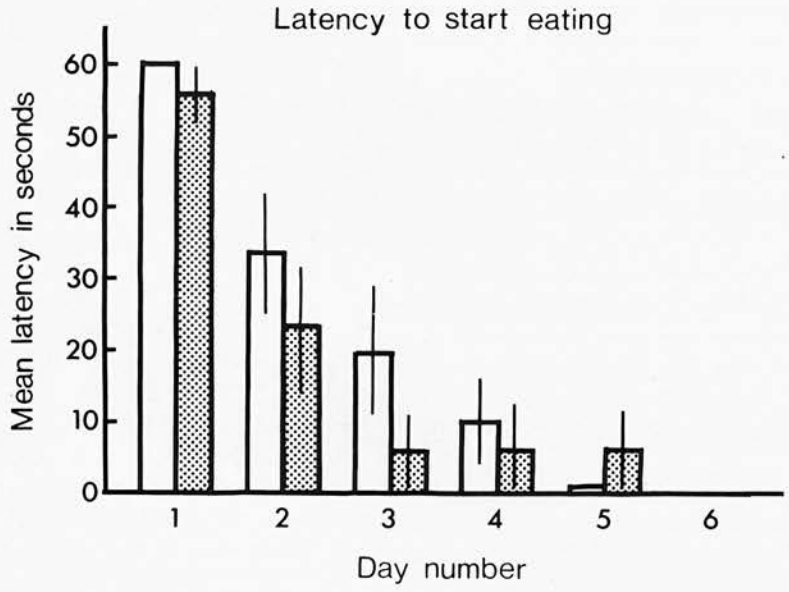
The responses of each bird at each stage were scored along a scale with the lowest score representing minimum withdrawal and the highest score maximum withdrawal from the experimenter. The scores accorded to each response at each stage are shown in Table D 1. Since not all responses could be shown at eage stage (e.g. birds could not step out of the cage until it was opened), equivalent scores did not represent equivalent responses for the different stages of observation.

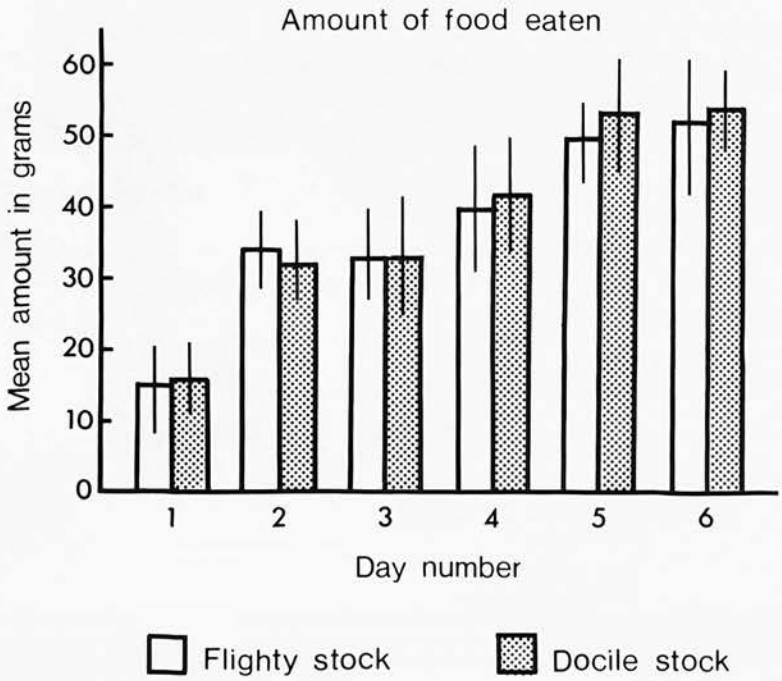
Analysis As the results were expressed in an ordinal scale, non-parametric techniques were used for their statistical analysis. For each day scores were compared between stocks (within each treatment group) and also between treatments (within each stock) by the Mann-Whitney U-test, 2-tailed.

Within-bird comparisons of responses in the battery cage and in the experimental cage were made with the Wilcoxon Matched-Pairs, Signed-Ranks Test. Within each stock-treatment class the scores obtained on each of the 6 days were compared by a Friedman One-Way Analysis of Variance to detect any change in response with time.

Figure D 1

Behaviour of 24h food-deprived birds when isolated in the experimental cage with food on each of 6 successive days.
The daily mean ± SE latencies to eat (in seconds) and the mean ± SE amounts eaten (in grams), by birds of each stock.





Results The deprived birds of both stocks quickly adapted to eating in the sound-proof room. On their first day there five flighty-stock and six docile-stock birds ate. One of the docile-stock birds began to eat 30s after being placed in the cage but no other birds had begun to eat during the 60s that the experimenter was present in the room. Over the whole six days the latency to start eating fell significantly - flighty-stock ($p < 0.01$) and docile stock ($p < 0.02$). This may be seen in Figure D 1. The only significant difference between pairs of consecutive days was for the docile stock between days 1 and 2 ($p < 0.02$). In the docile stock all but one bird was starting to eat immediately on being placed in the cage by the third day; all but one of the flighty-stock birds were doing so by the fifth day.

As Figure D 1 shows there was in both stocks an overall increase over the six days in the amount of food eaten, flighty stock ($p < 0.01$), docile stock ($p < 0.05$). There were no significant differences between the two stocks on any day in either the latency to start eating or the amount eaten.

The results and statistical analyses pertaining to the responses of the birds at each of the five stages of removal from the cages were rather numerous. They are summarised as briefly as possible in the following text with the aid of diagrams and are presented more fully as tables in the Appendix.

a. Removal from home battery cage

On each of the six days the flighty-stock birds of both non-hungry and deprived groups had higher mean scores, i.e. they showed more withdrawal from the experimenter, than did the docile-stock birds. In forty-six out of fourty-eight cases the differences in scores between the two stocks reached statistical significance. No flighty-

stock bird ever showed active approach such as clawing at the front of the cage or pecking the experimenter's hand whereas several docile-stock birds did so; conversely active withdrawal such as jumping up at the back of the cage and panicking was shown only by flighty-stock birds.

Within neither stock were there any significant differences between the scores of non-hungry birds and those of deprived birds. In none of the four groups was there any significant change in the response scores over the six days.

b. Removal from the experimental cage

The responses of the birds when being removed from the experimental cage showed some very interesting differences to their responses on being removed from the battery cage. When the experimenter stood in front of the experimental cage (Stage 1) there were no significant differences at all between the scores of the two stocks. The flighty-stock birds showed less withdrawal when being removed from the experimental cage as compared to being removed from the battery cage and the docile-stock birds did not approach the experimenter as much in the experimental cage as they did in the battery cage. In other words all the birds tended just to stand still in the experimental cage.

When the experimenter placed her hands on the experimental cage, the flighty-stock birds again showed much less withdrawal than when in the battery cage although the docile-stock birds responded much as they had done in the battery cage. There was however still some overlap in the mean scores of the two stocks in the experimental cage.

Both when the experimenter opened the experimental cage and when she reached for the bird the docile-stock birds behaved as they had done

in the battery cage. The flighty-stock birds still showed significantly less withdrawal in the experimental cage than in the battery cage when the cage was opened. But when reached for, the flighty-stock birds responded with the same extreme withdrawal that they had shown in the battery cages and their scores were significantly higher than those of the docile-stock birds on each of the six days.

There were only two out of forty-eight instances of significant differences between scores of non-hungry birds and deprived birds of either stock when being removed from the experimental cage.

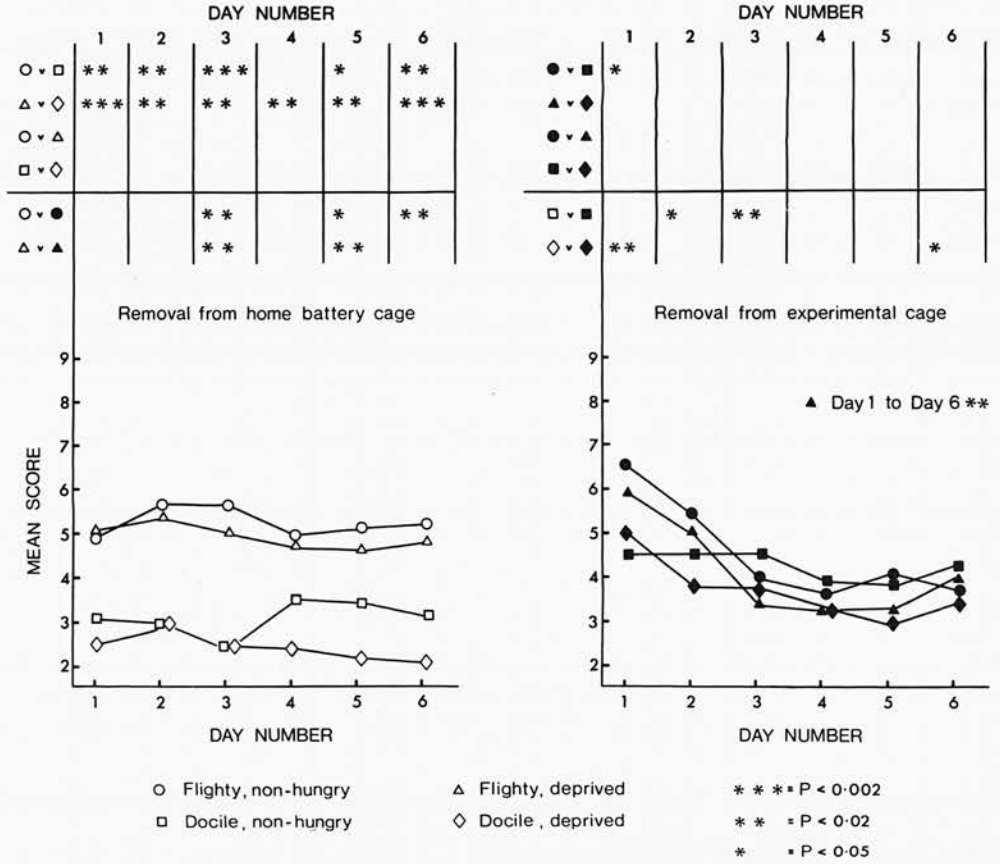
In the flighty-stock non-hungry group there was an overall significant difference in the scores over the six days when the birds were reached for ($p < 0.02$). In the flighty-stock deprived group there was also a significant difference over the six days ($p < 0.02$) but this was when the experimenter stood in front of the experimental cage. However in neither of the cases was there any linear trend in the daily scores or any significant differences between successive pairs of days.

The following four figures, D 2-D 5, illustrate well the results of this experiment. The left hand graph on each graph on each page shows the responses of the birds when being removed from the battery cage. The great difference in scores between the two stocks and the similarity between the two groups within each stock is obvious. The right-hand graph on each page shows the responses of the birds when being removed from the experimental cage. The complete overlap of scores when the experimenter was standing in front of the cage (Stage 1) and the gradual separation of the scores such that by stage 4 both stocks were behaving again as in the battery cages may be seen.

F i g u r e D2

The daily mean response scores obtained by birds of each stock-treatment class, together with the results of the statistical analyses.

Stage 1. Experimenter stands in front of cage



F i g u r e D3

The daily mean response scores obtained by birds of each stock-treatment class, together with the results of the statistical analyses.

Stage 2. Experimenter places hands on cage.

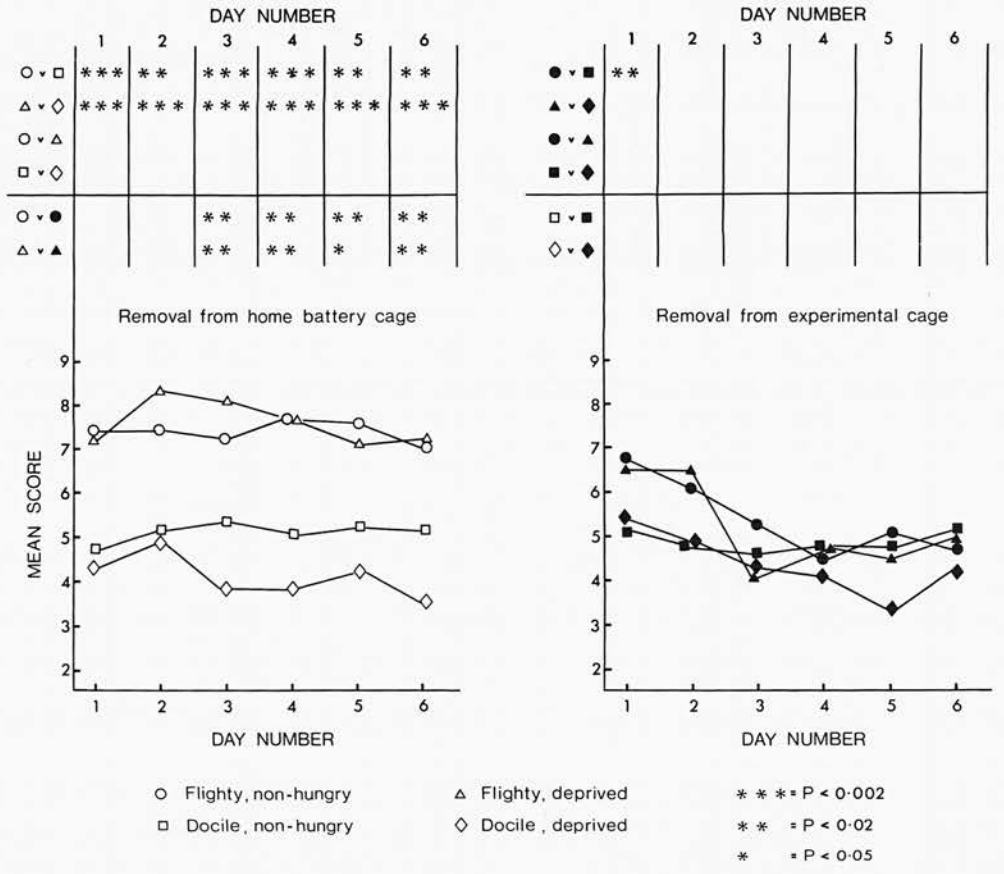


Figure D 4

The daily mean response scores obtained by birds of each stock-treatment class, together with the results of the statistical analyses.

Stage 3. Experimenter opens the cage.

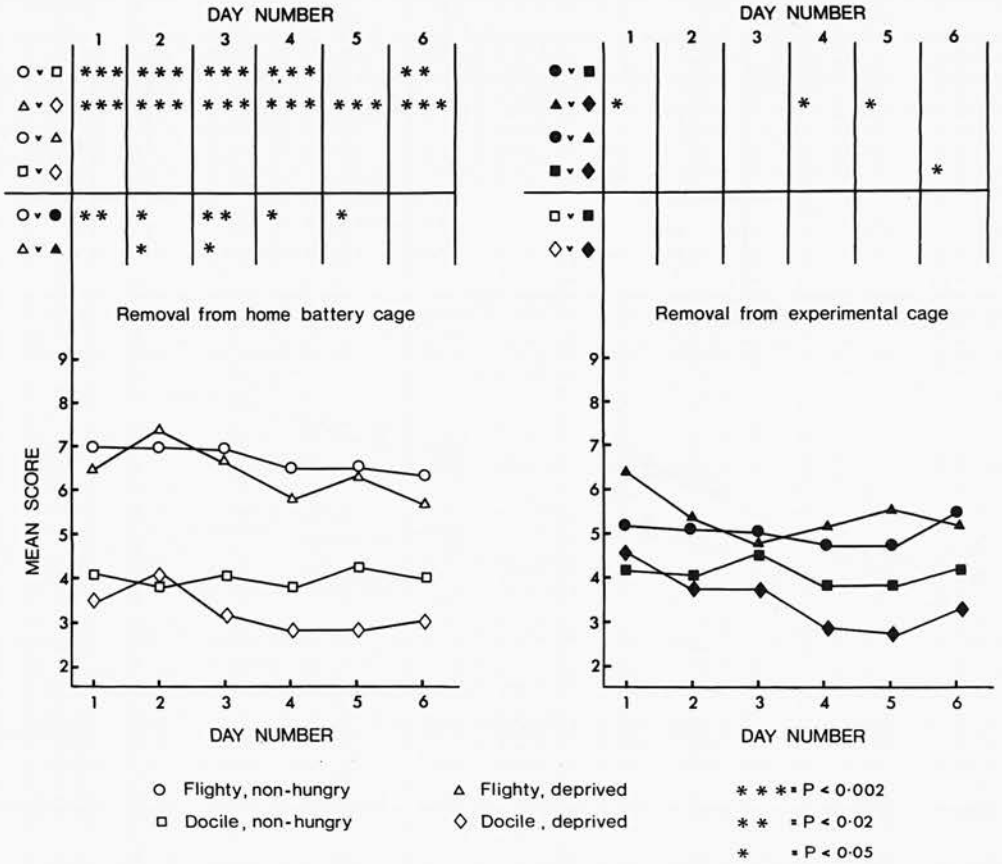
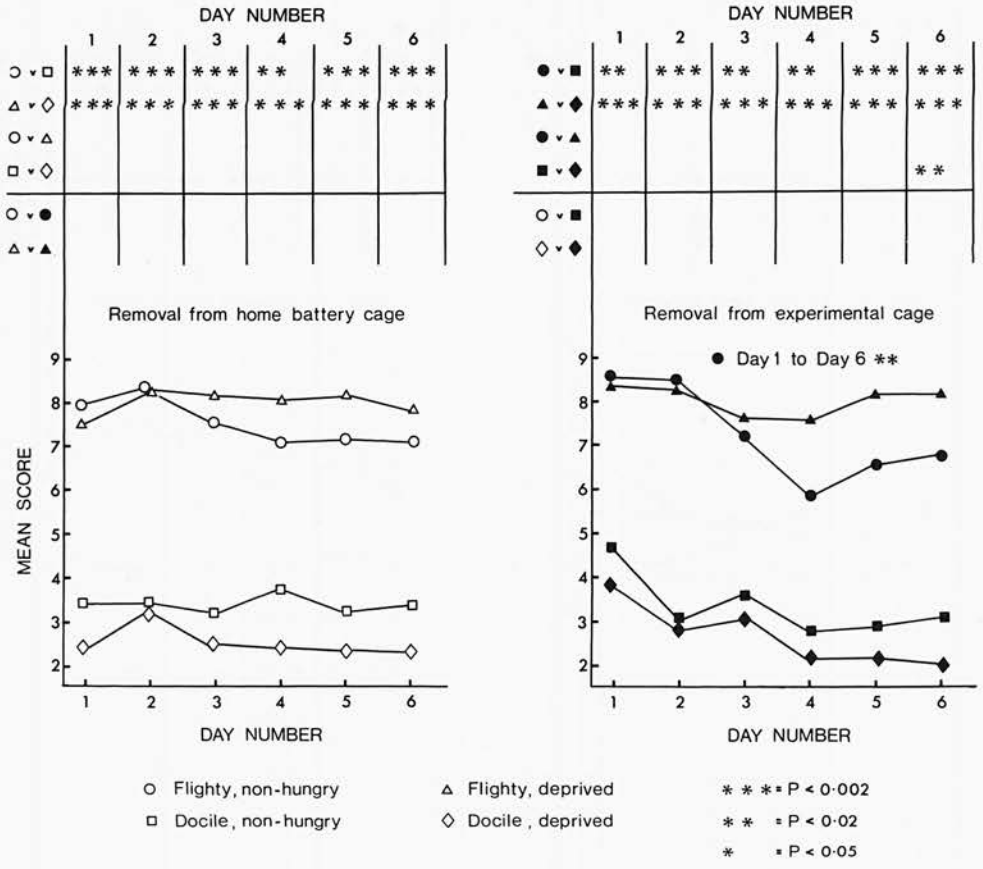


Figure D 5

The daily mean response scores obtained by birds of each stock-treatment class, together with the results of the statistical analyses.

Stage 4. Experimenter reaches for bird.



At the top of each graph the results of the statistical comparisons for each of the six days are shown. The two top rows show comparisons between flighty-stock and docile-stock birds of the same group; the middle two rows compare non-hungry and deprived groups of the same stock; and the lower two rows compare responses between the battery cage and the experimental cage within each stock-treatment class. On each graph the clear symbols represent mean daily scores for each stock-treatment class in the battery cage and the solid symbols the same classes in the experimental cages.

In tables D 2 A - D 9 A the results of stages 1-4 are presented more fully.

c. Stage 5

The bird is picked up The vocalisations emitted by the birds as they were grasped were in the majority of cases of a distressful nature. The flighty-stock birds tended to emit one or two rather long squawks whilst amongst the docile-stock birds several short clucks were more common. A few soft calls were also emitted by birds of both stocks. The presence or absence of vocalisation was fairly evenly distributed between different birds and different days. The number of birds emitting each of these vocalisations over the total six days is shown overleaf.

1. On removal from battery cage

Class	Vocalisation		
	Squawk	Cluck	Soft call
Flighty-stock non-hungry	16	0	4
Docile-stock non-hungry	1	32	2
Flighty-stock deprived	20	3	0
Docile-stock deprived	3	23	2

There were vocalisations within each class on each day and nearly all birds called on at least one day.

2. On removal from experimental cage

Class	Vocalisation		
	Squawk	Cluck	Soft call
Flighty-stock non-hungry	11	2	0
Docile-stock non-hungry	4	23	1
Flighty-stock deprived	11	3	0
Docile-stock deprived	0	16	2

Both stocks had slightly smaller numbers of vocalisations on removal from the experimental cage involving slightly fewer birds.

d. Defaecation in the experimental cage

Whether or not each bird had defaecated when in the experimental cage each day was noted. The presence or absence of defaecation was fairly evenly distributed between different birds and the number of birds defaecating on each of the six days is shown overleaf.

Class	Day 1	2	3	4	5	6	Total
Flighty-stock non-hungry	4	3	3	3	4	4	21
Docile-stock non-hungry	2	1	0	0	1	0	4
Flighty-stock deprived	1	1	1	1	1	2	7
Docile-stock deprived	0	0	0	0	0	0	0

There were more instances of defaecation by flighty-stock birds than docile-stock birds ($p < 0.001$, modified χ^2 Test).

Discussion One of the main points of interest to arise from the results of this experiment was the failure of the experimental treatment to have any effect on the behaviour of birds of either stock towards the experimenter. In neither stock did any significant differences in response to the experimenter develop between non-hungry and deprived groups, apart from one isolated instance. This was in the docile-stock group on day 6 when being removed from the experimental cage at Stages 3 and 4; but here the differences was in the direction opposite to that expected, for the non-hungry birds showed more withdrawal than the deprived birds.

There was a significant reduction in the withdrawal scores of the flighty-stock non-hungry birds over the 6 day period at stage 4 (reach for bird) when being removed from the experimental cage. However there were no significant reductions at all in the withdrawal of the deprived flighty-stock birds when they were being removed from the battery cage to be fed. These birds obviously were adapting to the experimental situation in other ways - there was a daily reduction in their latency to start eating in the experimental cage and a daily increase in the amount of food eaten. The non-hungry docile-stock birds did not show any decrease in their approach behaviour over the six days when the human being was removing them from their home cage to the isolated one. This general lack of an effect of the

treatments on the birds' behaviour towards human beings suggests a rather fundamental basis for these responses in the two stocks.

A second point of interest was the differences in behaviour of birds of both stocks, regardless of whether they were in a non-hungry group or a deprived group, when being removed from the home battery cage as compared to being removed from the experimental cage. On removal from the battery cage flighty-stock birds showed more extreme withdrawal than docile-stock birds at all stages. On removal from the experimental cage however this stock difference was not present either when the experimenter stood in front of the cage or when she placed her hands on it. The stock difference in response began to reappear only when the cage was being opened and it was completely re-established when the experimenter reached out for the bird. In an earlier experiment (C 1) it was discovered that there was no stock difference in the behaviour of non-hungry mature birds which were isolated in this same experimental cage; all the birds tended just to stand still. In the present experiment when the experimenter entered the sound-proof room and stood in front of the experimental cage the birds responded very much in the same way - by standing still. This strongly suggests that in both stocks responses to the sound-proof room situation were more highly motivated than responses to the human being, thus inhibiting the occurrence of normal responses to the human being. When the experimenter placed her hands on the cage the docile-stock birds responded more as they normally did in the home environment, but the flighty-stock birds largely remained standing still. It seemed therefore that for the flighty-stock birds even the stimulus of the

experimenter's hands on the cage, which in the home cage normally aroused rather strong withdrawal responses, was still not as intense as the stimulus of the sound-proof room situation and the motionless response which it evoked. Only when the experimenter opened the cage did the flighty-stock birds respond more as they did in their home cages; and they only responded entirely as in the home cages when the experimenter reached into the experimental cage towards them. In other words if the motivational states causing the typical withdrawal responses of the flighty-stock birds and the approach responses of the docile-stock birds towards human beings may be equated then there is evidence that the state of "emotional disturbance" produced by isolation in the sound-proof room was greater in flighty-stock birds than the docile-stock ones. Further, this would mean that in Experiment C 1 although birds of the two stocks behaved very similarly when isolated in the sound-proof room, the underlying motivational states were in fact at different intensities. However since it would be impossible to verify that the withdrawal and approach tendencies were directly comparable no definite conclusions based on the assumption can be drawn.

Defaecation in the experimental cage was more prevalent amongst flighty-stock birds than docile-stock ones in the present experiment. This was in fact the only occasion in which any abnormally high incidence of defaecation amongst mature birds was observed in an experimental situation. (There was one amongst chicks in experiment C 8). Since this high incidence did occur in the stock which it has been suggested was experiencing the greater degree of emotional disturbance there is some evidence, albeit very slight, that defaecation may after all be an "emotional response" in the domestic fowl. However the small proportion of birds which defaecated in the experimental cage on any one day emphasises the point made previously that, when no other

measures are taken, the incidence of defaecation does not seem a very reliable indicator of emotional disturbance in this species. Obviously no comparisons of defaecation incidence could be made between the non-hungry birds and those which had been deprived of food for 24h.

The same stock differences in the type of vocalisations emitted when handled occurred in this experiment as in those of Section A. (Flighty-stock birds tended to squawk and docile-stock birds to cluck). As discussed at that time the relative intensities of distress that these two call represent does not appear to have been systematically investigated. Collias and Joos (1953) reported that they have different causations; the "fear squawk" being typically given by birds when handled or seized by a predator, while the cluck is a "ground predator warning". If these are, as Collias and Joos imply, mutually inhibitory causations then both should not be shown in response to the same stimulus. Since they were, it appears that an explanation of the causation of adult calls, similar to that proposed by Andrew (1964) for chicks, is appropriate. This is that "vocalizations form a single system of responses evoked by stimulus contrast of differing persistence and intensity". A more detailed examination of the vocalizations emitted by birds during handling and other stimulus situations, and in particular a comparison of vocalizations with other behavioural responses would undoubtedly be of value. This is an obvious gap in knowledge of the behaviour of the domestic fowl, but unfortunately such an examination was outwith the scope of the present study.

It may be felt that a period of 6 days was not sufficiently long to allow large changes in the responses of birds to human beings to occur. However it was long enough to allow large changes in their eating habits to occur. Similar, though less detailed, observations made on other

birds in an experiment not reported here showed that even after thirty days of an association between handling and feeding, the stock difference in responses was still as great.

Experiment D 2

Introduction This experiment, in which young chicks were observed, was basically similar in design to the previous one which used mature birds. However since it had been shown in experiment C 5 that isolation in a sound-proof room had a differential effect on chicks of the two stocks, only the availability of food was changed in the present experiment. There was thus minimal danger of responses to the Experimenter being confused with responses to a strange environment.

Materials and Methods Twenty chicks of each stock were observed and on the day of hatching each was placed in a standard chick-box. As it was important to prevent any imprinting of the chicks onto the experimenter each chick was provided with a companion chick of the same age and stock. At the back right-hand corner of each box was a glass water jar behind which the two chicks could stand. A Perspex food dish 14 x 6 x 8 cm high stood in the back left-hand corner; the chicks always stood inside the dish when eating. The boxes where the chicks were normally housed will be referred to as the "home boxes". A set of similar boxes the "experimental boxes" were kept in an adjacent room where there was a similar background noise. A pilot experiment indicated that the chicks behaved quite normally when placed in the experimental boxes.

The chicks of each stock were randomly divided into two groups of ten chicks each, a non-hungry and an experimental, or deprived group. In the home boxes the non-hungry group were supplied with

food ad libitum. On hatching day the experimental chicks were supplied with 5 g mash per box to enable them to familiarise themselves with both the food and the food dish. This amount was consumed within 4-5h. Thereafter they had no food in the home boxes.

Observations began on the day following hatching, Day 1. On this day and on the following five, each chick was transferred with its companion from it home box to an experimental box where they were left for 30min and then returned to the home box. The chicks were allowed longer to eat than the mature birds (which had only 15min) because mash cannot be ingested as quickly as pellets. The food dishes in the experimental boxes contained mash in the case of deprived chicks and were empty for non-hungry chicks. In both boxes the chicks were always placed in the food dish and then observed for 1min. The number of chicks which started to eat within this period was noted on each day. It was impractical to measure latencies to eat since chicks either began to eat immediately or jumped straight out of the dish and walked around the box, not returning to the dish for several minutes. The amount of food eaten by each deprived chick each day was measured.

The experimenter noted the responses of each chick on each day as it was being removed from both boxes. In particular the responses at each of the following stages were recorded:-

Stage 1 Experimenter stands at box

The Experimenter stood in front of the box and looked down into it. If the chicks were asleep the Experimenter waited until they awoke, rarely more than 15min. It was decided not to use an auditory stimulus to waken sleeping chicks in case they formed conditioned responses to this stimulus which would interfere with those then shown to the Experimenter.

Table D 10

The responses of chicks at each stage of contact with the Experimenter and the score allocated to each.

SCORE	STAGE 1 AT BOX	STAGE 2 HAND IN BOX	STAGE 3 REACH FOR CHICK
1	Jumps up at front wall	Pecks hand	Pecks hand
2	↑↳ front of box	↑↳ F L C	↑↳ F L C
3	↑↳ centre of box or food dish	↑↳ centre of box or food dish	↑↳ centre of box or food dish
4	↑↳ back of box	↑↳ B R C	↑↳ B R C
5	Runs to back of box	Backs slowly away	Backs slowly away
6	Jumps up at back of box	Runs to back of box	Runs to back of box
7	Panic	Jumps up at back of box	Jumps up at back of box
8	-	Panic	Panic

F L C = Front left-hand corner of box (where the Experimenter's hand was placed)

B R C = Back right-hand corner of box (further point from hand)

↑↳ = Walks to or stays at - - - - -

Stage 2 Experimenter places hand in box

The Experimenter slowly placed one hand down into the box in the front left-hand corner until the fingertips were touching the floor of the box.

Stage 3 Experimenter reaches for chick

The Experimenter slowly moved her hand across the floor of the box towards the chick.

Stage 4 Experimenter picks up the chick

A chick was picked up by placing a hand over its back and enclosing the chick gently in it so that its head was covered.

The responses of the chicks at each of these stages were scored along a scale with the lowest score representing minimum withdrawal and the highest score maximum withdrawal from the front of the box (stage 1) and from the Experimenter's hand (stages 2 and 3).

The scores awarded to each response at each stage are shown in Table D 10. Since not all responses could be shown at each stage equivalent scores did not represent equivalent responses for the different stages.

The statistical analyses of all the results were carried out as described for Experiment D 1.

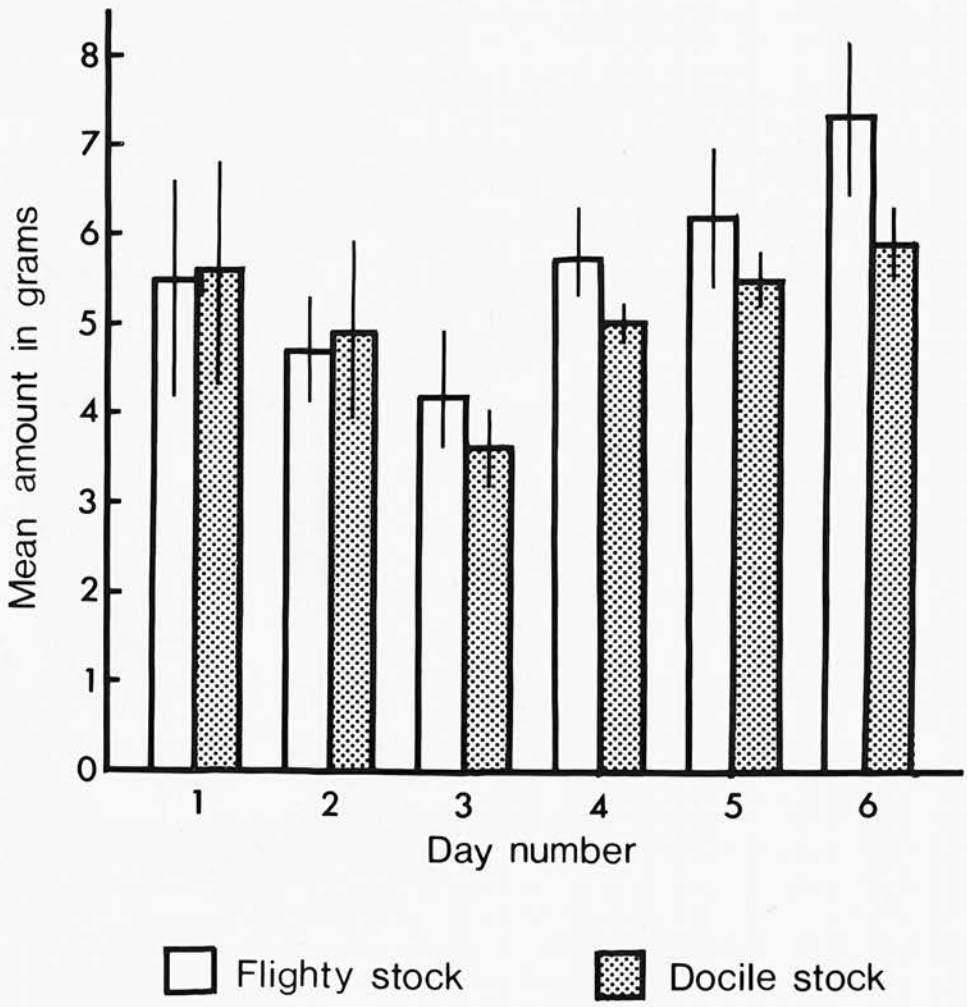
Five non-hungry and five experimental chicks of each stock were observed during one week and the remaining half during another week. Each week the order in which the chicks were observed each day was randomised.

Apart from the daily observations the chicks were not exposed to human beings at all during the course of the experiment.

Results The deprived chicks of both stocks quickly adapted to eating in the experimental box. The number of chicks which began to eat

Figure D 6 Exp D 2

Behaviour of 24h food-deprived chicks when isolated in the experimental box with food on each of 6 successive days.
The daily mean ± SE amounts eaten (in grams), by chicks of each stock.



within 1min of being placed in the experimental box on each of the six days is shown below.

	Day Number					
	1	2	3	4	5	6
Flighty stock	1	3	5	7	10	10
Docile stock	0	3	5	9	10	10

All of the deprived chicks ate on each of the six days, there being no stock difference in the amounts eaten on any day. In both stocks the mean amount eaten decreased from day 1 to day 2 and again from day 2 to day 3. Thereafter there was a daily increase. This may be seen clearly in figure D 6.

As in experiment D 1 the responses of the chicks to the experimenter during the six days will be presented briefly in the text with more comprehensive tables given in the Appendix.

a. Removal from Home Box

When the experimenter stood beside the box (Stage 1) all the chicks, regardless of stock or treatment appeared indifferent to her presence. In fact none of the chicks ever showed signs that they had perceived the Experimenter - there was neither withdrawal nor approach and also no fixating or startle responses.

Both when the experimenter placed her hand in the box and when the hand approached the chicks the flighty-stock chicks had higher mean scores, showing greater withdrawal, than the corresponding docile-stock chicks in twenty-three out of twenty-four cases; these differences reached statistical significance in thirteen cases. Jumping up at the back of the box and panicking were shown only by flighty-stock chicks; while nine different docile-stock chicks pecked at the experimenter's hand only two flighty-stock chicks ever did so.

In the flighty stock there was one isolated instance of a significant difference in response scores between deprived and non-hungry chicks. In neither of these groups was there any significant change in responses over the six days. In the docile stock the deprived chicks showed more approach towards the experimenter than did the non-hungry chicks, the differences in the response scores being significant from day 3 onwards when the experimenter placed her hand in the box and on days 3, 5 and 6 when the experimenter approached the chicks. The change in scores of the deprived chicks over the six days was highly significant for the responses to the hand in the box.

b. Removal from Experimental Box

The stock difference in the behaviour of the chicks when removed from the experimental box was very similar to that when they were removed from the home box, within both the non-hungry and the deprived groups. There was no stock difference when the experimenter stood beside the box; but when she placed a hand in it and when the chicks were approached the flighty-stock chicks had greater mean scores, showing greater withdrawal, than the corresponding docile-stock chicks on all 6 days. These stock differences in the response scores were statistically significant in ten out of twenty-four cases.

In neither stock were there any significant differences between the scores of non-hungry and deprived chicks. There were also no significant changes in the scores over the 6 days in any of the four stock-treatment classes.

c. Comparison of home box and experimental box

When the experimenter placed a hand in the box the chicks of all classes, except the docile-stock deprived chicks, behaved very much alike in both boxes. The docile-stock deprived chicks showed much more approach

when being removed from the home box than when being removed from the experimental box and on days 4, 5 and 6 the differences in these scores reached statistical significance.

Within none of the four classes were there any significant differences in response to the approach of the Experimenter's hand dependant upon whether the chicks were in the home box or in the experimental box.

The results of Stages 1, 2 and 3 are illustrated graphically in Figures D 7, D 8 and D 9 (overleaf). The similarity between responses in the home box and responses in the experimental box are clearly seen here.

Tables D 11 A - D 16 A give the results more fully.

d. Stage 4 Experimenter picks up the chick

When lifted up chicks either remained silent, peeped or twittered; (Andrew's 1964 nomenclature of vocalisations has been followed). The number and distribution of vocalisations was almost identical in the home box as compared to the experimental box. In both cases peeps were more common amongst flighty-stock than docile-stock chicks ($p < 0.001$, modified χ^2 Test). Twitters were more common, although not significantly, amongst docile-stock chicks. Whether chicks belonged to a non-hungry or to a deprived group did not significantly affect the type of vocalisation shown. Within each of the four stock-treatment classes the incidence of vocalisations was fairly evenly distributed between different chicks and different days. The total number of chicks responding in each of the three ways observed over the total six days is shown overleaf.

Figure D 7

The daily mean response scores obtained by chicks of each stock-treatment class, together with the results of the statistical analyses.
Stage 1. Experimenter stands at box.

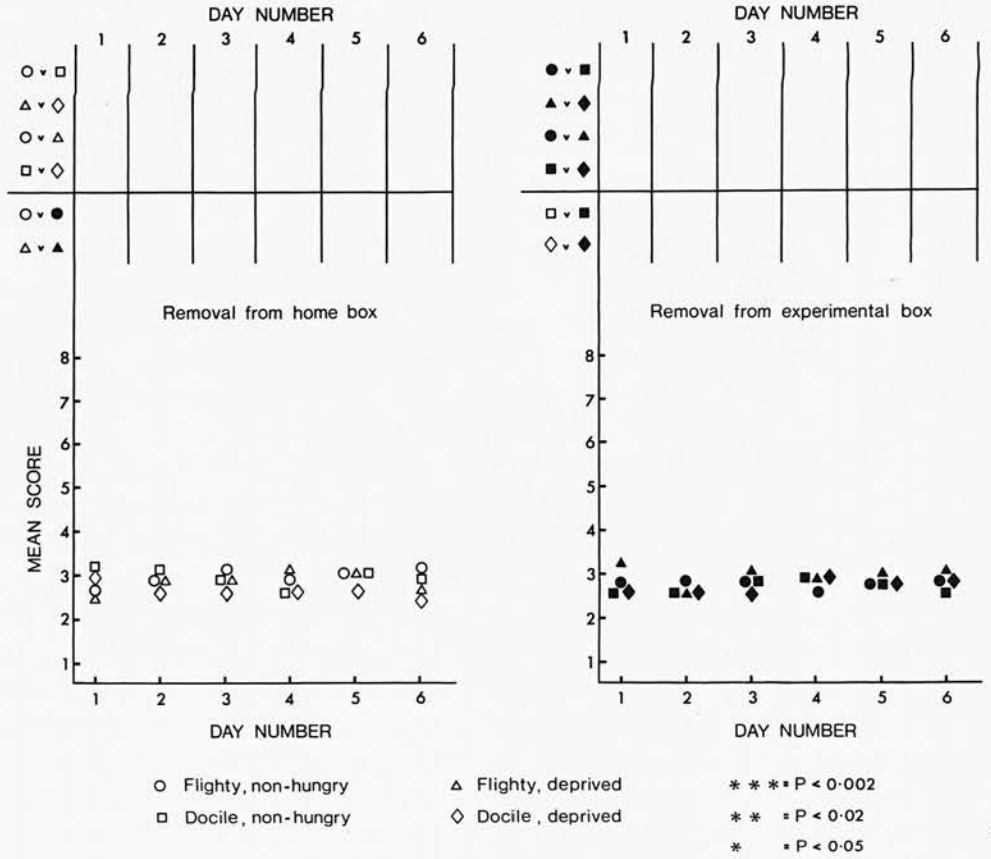
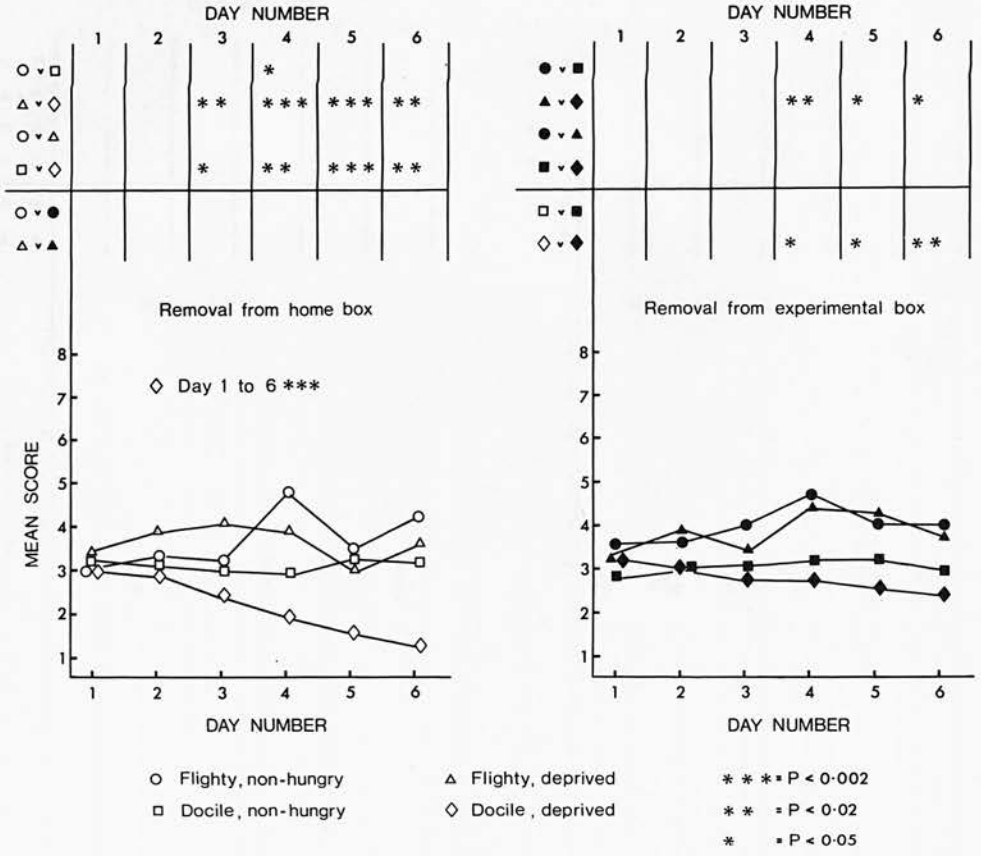


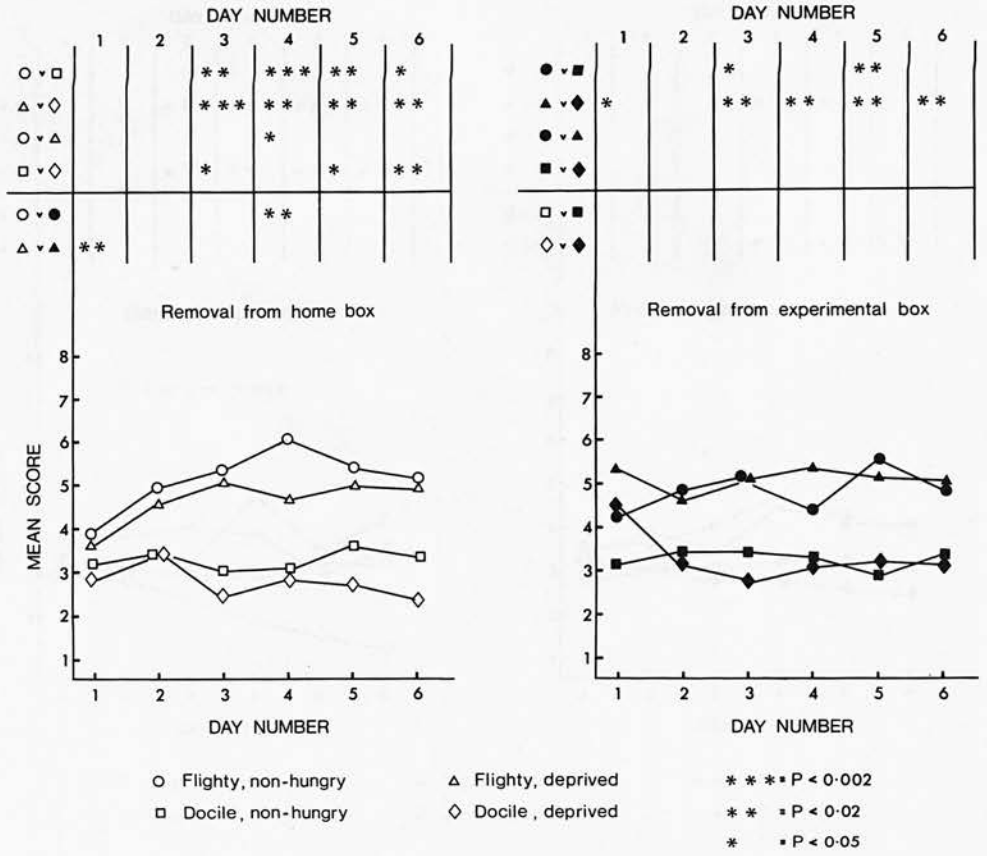
Figure D 8

The daily mean response scores obtained by chicks of each stock-treatment class, together with the results of the statistical analyses.
Stage 2. Experimenter places hand in box.



F i g u r e D 9

The daily mean response scores obtained by chicks of each stock-treatment class, together with the results of the statistical analyses.
Stage 3. Experimenter reaches for chick.



Vocalisation	Silent		Peep		Twitter	
Box	Home	Exp.	Home	Exp.	Home	Exp.
Flighty-stock non-hungry	33	34	27	26	0	0
Docile-stock non-hungry	47	50	9	10	4	0
Flighty-stock deprived	30	32	29	28	1	0
Docile-stock deprived	40	40	11	15	9	5

Discussion There was an almost complete failure of the experimental treatment to significantly affect the responses of the flighty-stock chicks towards the experimenter. It is true that when the experimenter moved her hand towards the chicks to remove them from the home boxes the flighty-stock deprived chicks had lower mean scores, showing less withdrawal, than the flighty-stock non-hungry chicks on each of the six days. However these differences in scores were very slight and only statistically significant on one of the six days. There were two out of a possible sixty incidences of deprived flighty-stock chicks pecking the experimenter's hand (no non-hungry chicks did so) and two incidences of non-hungry flighty-stock chicks panicking (no deprived chicks did so). Apart from this there were no qualitative differences in the behaviour of non-hungry and of deprived flighty-stock chicks. These findings support the hypothesis proposed at the end of the previous experiment that the withdrawal responses shown by flighty-stock birds to certain stimuli are not easily modified by environmental factors.

The treatment did however have some significant effects on the responses of the docile-stock chicks. In the deprived group the incidence of active approach responses when the experimenter placed her hand in the home box, increased significantly over the six days to such an extent that during days 2-6 inclusive their scores were

significantly lower than those of the docile-stock non-hungry chicks. Not only were the most active approach responses (score 1) shown only by deprived chicks but withdrawal responses (scores 4 and 5) were shown only by non-hungry chicks. That such significant changes in behaviour did occur amongst the docile-stock chicks over the six days indicated that this amount of time was ample to allow the formation of an association by newly-hatched chicks of a human hand and a food reward.

In this experiment the environments in which the home boxes and the experimental boxes were kept did not differ in a manner analgous to that of the mature birds' battery cages and experimental cages in the previous experiment. Thus it was not expected that the non-hungry chicks should respond very differently according to the box from which they were being removed. This was indeed found to be the case and with the single exception of the flighty-stock non-hungry chicks on day 4 there were no significant differences in the responses of non-hungry chicks dependent upon which box they were in. This was in marked contrast to the corresponding situation for mature birds in the previous experiment in which the birds behaved very differently according to which cage they were in.

It was however obviously expected that deprived chicks might differ in their responses when being removed from the two different boxes. Amongst the docile-stock deprived chicks this did happen and when the experimenter placed a hand in the box these chicks showed more approach responses when being removed from the home box - the reward situation - than when being removed from the experimental box - the no-reward situation. In other words the docile-stock chicks

appeared to be responding not to the stimulus of the approaching hand itself but to the associated stimulus of reward or no-reward. The relative lack of approach responses from the docile-stock deprived chicks when the Experimenter's hand approached them was because most of the chicks were already standing so close to the hand that further approach was physically impossible.

However amongst the flighty-stock deprived chicks there were, apart from a single exception on Day 1, no significant differences in the responses of the chicks dependant upon which box they were in. This indicated that in the flighty stock chicks the stimulus of the approaching hand itself, which elicited withdrawal, was relatively more intense than the associated stimulus of a food reward, which would be expected to elicit approach.

Experiments D 3 and D 4

Introduction and Literature Review

In the previous experiment, D 2, two flighty-stock chicks did actually approach and peck at the experimenter's hand. These numbers were of course very small but nonetheless important in that they did indicate that the usual withdrawal responses of the flighty-stock chicks were modifiable, although in the corresponding mature birds of experiment D 1 there was no such extreme approach. These findings suggest that there is a greater scope for modification of responses to human beings with chicks than with mature birds.

It has been repeatedly demonstrated in a wide variety of species that experiences occurring during an individual's early life can affect its later behaviour in a way that the same experiences occurring later

in life cannot. Some of the early-experience variables which affect the defaecation response of rodents in an Open Field have already been listed in Table C 1. Examples of other aspects of behaviour which are affected by various experiences in early life are listed in Table D 17. From the available literature a wide range of species and of affected behaviour patterns have been selected to illustrate the generality of this phenomenon; but the direction of the changes in subsequent behaviour have not been shown. These were omitted partly because in comparable studies they were not always the same but also because the Table is mainly intended to demonstrate the wide range of species and of juvenile and adult behaviour patterns involved. Various theories have been proposed to explain the mechanisms by which these early experiences exert their influences and most of these are concerned with rodents. It is beyond the scope of this thesis to examine these theories here in detail. It need only be said that most of them provide evidence that the amount of "general stimulation", in the form of, for example, handling, electric shock treatment or complexity of environment that an animal receives during the first weeks of life has a permanent effect on the developing adrenocortical system. This in turn affects the behaviour of that animal in later life in any situation in which this system is involved and explains the great variety of behaviour patterns which may be affected. The various theories differ mainly with respect to the relationship between the amount of infantile stimulation necessary to produce various amounts of change in later behaviour and whether these two variables are related in a linear or a curvilinear fashion. Hinde (1970) and Gray (1971) both review the subject well and emphasise the importance of interactions between inherited and environmental variables.

Table D 17 (page 1)

Some examples drawn from various species of behaviour patterns whose expression in later life is affected by experiences in an individual's early life.

AUTHOR & DATE	SPECIES OR BREED	EARLY EXPERIENCE VARIABLE	AFFECTED LATER BEHAVIOUR
Weininger 1953	Domestic rat	Whether handled after weaning	Length of survival time under food and water deprivation
Seitz 1954	Domestic rat	Litter size	Adult weight; hoarding tendencies; exploration; reaction to handling
Thompson & Melzack 1956	Scottish Terrier	Post-weaning rearing in isolation or with social contact	General activity; emotionality; responses to novel stimuli; intelligence
Kuo 1960 a & b	Japanese quail	Reared in isolation or in a social group	Level of aggressiveness
Kruijt 1962	Burmese Red Jungle Fowl	Reared in isolation or in a group	Escape responses; aggressiveness copulatory behaviour
Menzel et al 1963	Chimpanzee	Reared in the wild or in a restricted laboratory environment	Responsiveness to novel objects
Warriner et al 1963	Pigeon	Colour of parent birds	Colour of mate chosen by male
Manosevitz et al 1968	Domestic mouse	Degree of environmental enrichment	Hoarding
Ader 1969	Domestic rat	Handling or electric shock treatment	Age at which 24h adrenocortical rhythm develops
Broom 1969	Domestic fowl	Visual experience of moving objects	Responsiveness to a novel visual object

Table D 17 (page 2)

AUTHOR & DATE	SPECIES OR BREED	EARLY EXPERIENCE VARIABLE	AFFECTED LATER BEHAVIOUR
Ader 1970 (review)	Domestic rat	Handling or electric shock treatment	Susceptibility to disease
Ader & Deitchman 1970	Domestic rat	Handling of mother during pregnancy	Age at which 24h rhythm in overt activity appears in offspring
Ivinskis & Kelly 1972	Domestic fowl	Reared in isolation or in a social group	Level of aggressiveness
Rosenzweig & Bennett 1972	Domestic rat	Degree of environmental enrichment	Brain weight and brain enzyme activity
Morgan 1973	Domestic rat	Degree of environmental enrichment	Learning ability in motor skill tasks

The two experiments described here were intended to determine if different amounts of "general stimulation" during the first few weeks of life would affect the subsequent behaviour of birds of the two stocks, in particular their responses to human beings. The experiments of the previous Sections show beyond doubt that terms such as "general emotionality" or "fearfulness" are misleading when applied to domestic fowl, at least of the two stocks studied here. Which of the two stocks appeared more fearful depended on the age of the birds observed and on the fear-provoking situation. It was therefore not possible in the present experiment to observe how birds reared differently responded in one situation, for instance an Open Field test, and from the results predict how the rearing would have affected responses in other situations, for instance responses to novel objects. Birds with different rearing histories were therefore observed in a variety of situations - in a strange environment, when a novel object was placed in the home environment, and when approached by human beings.

The "general stimulation" variable which was chosen was whether or not the birds had visual contact with human beings during the first 6 weeks after hatching. One group - the Unseen group was reared in a somewhat restricted environment, being kept entirely without visual contact with human beings. The other group - the Seen group was reared in a pen next to the main door of the poultry house; they were therefore exposed to a fairly constant passing-by of people throughout the day and could also see the people moving around in their own pen. This variable was chosen partly because it involved the type of rearing treatment difference which has been found to affect later behaviour in other species, but mainly because the subsequent behaviour of the birds towards human beings could then be compared in the Seen and Unseen birds. It is in responses to human beings, rather than to strange

environments or to novel objects that the most consistent stock differences have been found in this study. However it has not been possible to determine exactly which property or properties of human beings release the typical withdrawal response in the flighty-stock birds. It might be their large size, the fact that they often "approach" birds, the fact that they often encroach upon birds' flight distances, or any combination of these factors. Unfortunately by the time normally-reared birds are old enough to perceive and recognise a whole human being they have probably already formed associations between for instance stationary and approaching people, making it impossible to separate these variables. On the other hand, birds reared without ever seeing a human being have no opportunity to form any such associations or to gradually habituate in their responses and the behaviour of these birds, if different to that of normally reared birds, should indicate how constant exposure to human beings has in fact influenced the behaviour of the normally-reared birds. For these reasons it was obviously desirable to rear the Unseen birds for as long as possible before exposing them to people. However, the sheer practical problems involved in such a rearing method, together with the time limitations imposed on this thesis meant that the birds could only be kept in the Unseen condition for 6 weeks. Nonetheless birds of this age should obviously be able to perceive a human being as such and the results obtained would indicate whether or not this is a useful experimental technique which could be further developed in the future.

When the birds were 6 weeks of age their initial responses to human beings were observed and during the following three weeks any changes in these responses were followed, to determine if the different rearing treatments had had very short-lived or more permanent effects.

During the 6 week rearing period none of the birds was ever handled, so there could be no question of subsequent responses to people being influenced by anticipation of being handled.

Subjects Thirty birds of each stock were used, fifteen in a Seen group and fifteen in an Unseen group, giving a total of four groups.

Description of rearing pen All the birds were reared in a single pen in the poultry house. A 2.4 m high wood partition screened off the back half of the pen where the Unseen birds were kept. The partition was hinged 30 cm above floor level to allow access to the floor area behind it. The Seen birds were kept in the exposed front half of the pen which adjoined a corridor through which people frequently passed in full sight of the birds. Both front and back halves of the pen were divided by 60 cm high wooden partitions into two areas each 100 x 80 cm. This gave four areas in the pen in each of which one stock-rearing group was kept.

The concrete floor of the pen was covered with wood shavings. Food and water containers were changed to suit the changing needs of growing birds. Constant heat and light were supplied by 275 watt bulbs suspended from the ceiling. These were gradually raised to decrease the temperature at floor level as the birds grew.

Rearing procedure The birds were placed in their respective areas of the pen on the day of hatching, remaining there until they were removed for observation at 6 weeks of age. Food and water were replenished twice daily, the lamps being switched off at this time to prevent the Unseen birds from seeing the experimenter's hands. Since the front half of the pen was open to the main floor of the poultry house switching off the lamps did not completely darken the Seen birds'

accommodation. The litter in each pen was changed every week, also in darkness. During this process some Unseen birds were occasionally touched with a brush, which however they could not see. The condition of the Unseen birds was checked daily by looking through a peephole in the dividing partition.

Experiment D 3

Introduction

a. Responses to a strange environment When the birds were 6 weeks of age they were observed when placed in isolation in a cage in the sound-proof room (see page 4 for description). As Table C 1 shows, the behaviour of rodents in an Open Field is affected by many variables of early-rearing experience and it was quite possible that the amount of human contact that the birds received during rearing would affect their responses to this strange environment. However, exactly how these responses might be affected or how any such influences might be mediated could not be presumed.

In experiment C 4, 6-week old birds reared in the brooder were observed in the sound-proof room. There was no stock difference in response and it was suggested that this was because all the birds were experiencing a very high degree of fear. If the Unseen rearing treatment of the present experiment resulted in birds which were less afraid of the strange environment than normally reared birds were, then differences might be expected (a) between the Seen and Unseen birds within each stock and perhaps also (b) between the flighty-stock and docile-stock Unseen birds.

On the other hand, if the Unseen rearing treatment resulted either in birds which were more afraid than usual of the strange environment or, if it had no effect on behaviour at this time then all the birds

would be expected to behave in the same way, by showing a very high degree of fear. In this latter case it would unfortunately not be possible to suggest which of these two reasons was responsible for this lack of difference in response.

Of course with the opposite type of fear-producing situation, one inducing minimal fear with all birds behaving alike, it would be impossible to distinguish between no treatment effect and the Unseen treatment resulting in birds which are less than normally afraid. The sound-proof environment was chosen because it was the only one in which there was no risk of environmental disturbances influencing the birds' responses. This was particularly important when the birds' initial responses to human beings were being observed, immediately following the observations on each bird in the strange environment.

b. Responses to a human being In order to separate the components of "approach" and distance between person and bird as potential variables in eliciting withdrawal responses of birds from human beings, the human being was moving away from the bird on the first occasion that each Unseen bird saw a person. Immediately following this, the human being did approach the bird to determine if this elicited a different type of response.

Methods

a. Responses to a strange environment The following procedure was used to transfer an Unseen bird to the sound-proof room. The lights in the home pen were switched off and the floor partition raised slightly. By placing an arm under the partition the Experimenter was able to feel for and to grasp a bird by its legs. The bird was brought out under the partition, still being held only by the legs, and its head immediately covered with a loose cloth. It was then

carried to the sound-proof room and observed in exactly the same manner as has been described for Experiments C 1-C 4.

b. Responses to a human being After the 15min observation described above was finished the Experimenter recorded each bird's responses to each of the following:-

1. The Experimenter stepped out at the side from behind the cloth screen which was directly in front of the cage and took a further two steps sideways away from the cage.

2. The Experimenter stepped towards the cage, approaching the bird and at the same time placed a hand on the cage front.

3. The Experimenter opened the cage door.

4. The Experimenter reached into the cage for the bird.

After a bird had been removed from the cage a plastic leg band was placed on each leg and it was returned, in darkness to its home area. Banding the birds prevented the experimenter from removing a bird which had previously been observed. The Seen birds were subjected to exactly the same procedure as the Unseen birds except that they were in dim light and able to see the experimenter approaching and removing them from the home area.

Three or four birds from each of the four groups were observed on each of four successive days. The order in which birds from the four areas were observed was randomised each day.

Results In each of the four stock-treatment classes a mean time of at least ten minutes of the fifteen minute observation was spent lying. Although the birds were placed in the cage in a standing position many had lain down before the lights were switched on, only a total of thirty-six out of sixty birds were observed to be standing at any time during the observation and of these only twenty-three walked around in the cage. The most common of the other activities recorded,

in terms of numbers of birds performing them, were eyes closed - thirty eight birds, defaecating - twenty eight birds, peeping - twenty four birds and nibbling - twenty three birds. In nibbling a bird opened and closed its beak which resulted in rather a loud noise in the silence of the sound-proof room; it is a behaviour pattern not commonly shown by birds in their home environment. Activities such as preening, scratching, yawning and pecking the environment were relatively uncommon.

Peeping was the only activity in which there was a significant stock or treatment difference in the number of birds performing it. More docile-stock birds peeped than did flighty-stock birds ($p < 0.001$) and more Seen birds peeped than Unseen ($p < 0.01$). The data concerning the numbers of birds performing each behaviour pattern is given in Table D 18 A. Analysis was by the modified X^2 Test.

The small proportion of birds performing most of the behaviour patterns meant that analysis of the times or incidences of performance could only be carried out on four patterns. These were, time spent lying, time spent with eyes closed, incidences of changing stance and incidences of defaecation. The mean values for these four patterns are shown in Table D 19 A. The Seen birds spent significantly longer than the Unseen birds with eyes closed ($F = 5.33$, $p < 0.05$); apart from which there were no significant differences due to either stock or rearing treatment.

When the observation period was over and the Experimenter appeared at the side of the bird's cage and moving away from it, responses tended towards one of two extremes. Either the birds did not react noticeably or with only a very slight startle, or else they flew

up and around the cage frequently squawking. The latter response was given by thirteen Unseen birds, seven flighty-stock and six docile-stock, but only two Seen birds ($p < 0.001$).

When the experimenter placed her hands on the cage and when the cage was opened nearly all of the birds stood still, there being no significant stock or rearing differences at this time. However when the experimenter reached out towards the bird eleven flighty-stock, seven Seen and four Unseen, and only four docile-stock birds, three Seen and one Unseen showed extreme withdrawal ($p < 0.05$), the remaining birds either standing still or backing slowly away. No birds ever approached the Experimenter.

The data are presented in Table D 20 A.

Discussion The different rearing treatments did not produce any qualitative differences in the behaviour of birds when isolated in a strange environment. There were however two significant quantitative differences which were at first sight rather difficult to interpret. Both peeping and eyes closed were more common in Seen than in Unseen birds; these are two of the behaviour patterns in which significant differences were found in young chicks (see experiment C 5). However in that case it was proposed that the incidence of peeping represented a relatively low level of fear whereas the incidence of eyes closed represented a relatively high level of fear and there was no incidence of both of these behaviour patterns being significantly higher in one group than in any other. Although the birds of the present experiment were a few weeks older than the chicks of experiment C 5 these two behaviour patterns are mutually inhibitory in birds of all ages and therefore are not normally expected to show differences in the same direction between groups of birds. However in the present

experiment the significant difference in peeping concerned the numbers of birds involved and even in groups in which these were relatively great the mean times spent peeping were small. The differences in eyes closed on the other hand concerned the time spent in this behaviour pattern, relatively large numbers of birds of all groups being involved. Bearing this in mind it is therefore not so paradoxical that peeping and eyes closed were both significantly greater in one group than in another.

Unfortunately this fact is of little help in deciding whether it was the Seen or Unseen birds which were experiencing the greater amount of fear. As discussed on page 5 differences in numbers of birds are probably more meaningful than differences in times spent performing a particular behaviour pattern and on this basis the difference in peeping should perhaps be given more weight than the difference in eyes closed in deciding which of the two rearing treatments, if either, had produced birds experiencing the greater degree of fear. However one of the conclusions reached from experiments in Section C was that peeping, taken alone, is a very unreliable indicator of the amount of fear experienced since the two do not appear to vary linearly with each other. Should therefore the time spent with eyes closed be taken as a measure of the amount of fear present? Usually, only birds which are lying close their eyes and there were no significant differences between the rearing treatments in either the time spent lying or standing or in any of the behaviour patterns directly related to either of these two body postures such as walking or beak on ground. It seems therefore that the significant treatment difference in eyes closed time was attributable to chance rather than to any general trend in response pattern attributable to a particular rearing treatment.

A comparison was made of the behaviour of the 6-week old birds of the present experiment and those of the same age but reared in the brooder and observed in the sound-proof room in experiment C 4. As different experiments were involved, carried out more than one year apart, statistical comparisons could of course not be made; but there were some very large and interesting differences between the two batches of birds. Eyes closed was for instance shown by only two of the thirty brooder-reared birds but by thirty eight of the sixty pen-reared birds; and while twenty six out of thirty brooder-reared birds stood, with twenty four of these walking around, only thirty six out of sixty pen-reared birds stood, with twenty three walking around. A major difference between the two batches of birds was the type of floor on which they were reared. The brooder had a cage floor, the same as the sound-proof room, but the pen-reared birds had never experienced anything other than a solid floor. It is very probable that the low incidence of standing and of walking and the high incidence of eyes closed shown by the birds reared in pens were a direct consequence of the strange floor rather than of the strange environment as a whole.

In addition to its relevance for the present experiment, the observation that a change or a lack of change in flooring could produce such very different results is of general interest. The birds did not appear to be disturbed by the change of floor, in the sense that they were not unsteady or unable to walk and there were other presumably more disturbing changes involved, such as the extreme silence and the loss of social companions. Therefore if only pen-reared birds had been used the typical responses of the birds - lying down and closing the eyes would most probably have been attributed to fear caused by the last two factors mentioned rather than by the change

in floor. Thus it would have been concluded that birds isolated in a silent environment express fear by lying down and closing their eyes whereas in fact this is very much an oversimplification. The general point to be made here is that it should never be presumed without firm experimental evidence which particular aspects of a fearful situation are in fact fear-evoking, and that in comparing results obtained from reportedly similar experiments from different laboratories such rather mundane details of the animals housing should be considered. Although the intensity of light and of sound to which rats are exposed in the Open Field are often said to be of importance in eliciting fear, the fact that rats are normally housed in cages whereas Open Fields are normally made of some solid substance such as hardboard is rarely if ever discussed in this context.

At the end of the 15min observation period when the Experimenter appeared beside the cage, withdrawal to the back of the cage was shown almost exclusively by Unseen birds - both stocks being equally involved. This observation helps in providing an answer to some of the questions posed by experiments in Sections A and B. It shows firstly that withdrawal responses are shown to a non-approaching human being by birds which have never had experience of approaching human beings. There is thus no evidence to support one of the suggestions made in Section A that flighty-stock birds withdraw from non-approaching human beings solely because they have formed an association between non-approaching people and people about to approach. However since the experimental situations of Section A and Section D differed in many aspects this finding cannot be taken as definite proof that such an association is not at least partly resonsible for the withdrawal

responses of birds which have been reared normally and are tested in their home environment.

The results of the present experiment also showed that "approach", defined as a lessening of the distance between a stimulus and a bird, is not a necessary component of a novel stimulus in order that it may elicit withdrawal. Such "approach" alone was thus probably not the sole character of the inflating balloon which made it such a powerful elicitor of withdrawal in experiment B 4. Considering also the point that the novel stationary object (windmill) used in experiment B 3 did not elicit withdrawal it seems in fact that there must be more than one stimulus property or combination of properties that are capable of eliciting withdrawal. For there was no property common to both the balloon of experiment B 4 and the human being of the present experiment which was not shared by the windmill. In the case of the approaching balloon it is probable that it was the extreme closeness of the balloon to the bird which caused withdrawal, whereas in the case of the receding human being the large size of the stimulus is a more likely candidate. Without the evidence of further experiments these suggestions can of course only remain speculative.

Why did nearly all of the Seen birds, as well as the remaining Unseen birds, remain standing still when the Experimenter appeared? The most probable explanation is that one already proposed for the lack of withdrawal shown by mature birds in experiment D 1. That is, that the stimulus of the sound-proof room and its resultant motionless response was more intense than the stimulus of the presence of a human being and thus inhibited the occurrence of the withdrawal

responses normally shown to human beings. To many of the Unseen birds however the completely novel stimulus of a human being must have been even more intense than that of the sound-proof room where they had been for the last 15min and there was no such inhibition of withdrawal responses.

Almost all of the birds of each stock-rearing class stood still when the Experimenter placed a hand on the cage and when the cage was opened. In the Seen birds this was again presumably because responses to the sound-proof room were inhibiting responses to the Experimenter. Whether the Unseen birds were remaining still because this now also applied in their case or because, having just performed one withdrawal response, they were less likely to perform another, could not be determined.

When the experimenter reached into the cage approaching the birds, it appeared that stock, rather than rearing treatment determined the type of response given and more flighty-stock than docile-stock birds withdrew. The number of flighty-stock birds withdrawing was however less than half of the total number, which was in contrast to the mature birds of experiment D 1, of which a far greater proportion of birds showed active withdrawal. Comparisons between different ages of birds always requires extreme caution. However in the present case there was one very obvious factor which may well have accounted for this age-related difference. This was the point, discussed above, that the 6-week old birds used in the present experiment had never previously experienced a wire mesh floor, whereas the mature birds of experiment D 1 were normally housed in cages. It has already been proposed that the strange floor affected the behaviour of the 6-week old birds during the 15min that they were observed while undisturbed in the experimental cage and it is equally possible that any responses

to the Experimenter involving any type of movement across the cage may also have been inhibited by the strange floor. If this were so it again demonstrates the importance of defining fully and taking into consideration all the aspects of any "fearful" situation before reaching any conclusions on the responses of animals to one particular aspect of that situation.

Experiment D 4

Introduction This experiment investigates how the responses of the Seen and Unseen birds to human beings changed during the 3 weeks following the first occasion that Unseen birds saw a human being. During this 3-week period all the birds were kept together and had approximately one hour daily of contact with human beings. On the first occasion that the Unseen birds saw a human being a significantly greater proportion of these birds than of normally reared birds withdrew from the person. This indicated that the flight distances to a human being were different in the two groups of birds. In the present experiment the Experimenter thus spent part of each daily observation sitting quietly 1.5 m away from the birds. Although it is not possible to state that no normally reared flighty-stock bird will retreat from a human being this distance away it is true to say that the majority of them will not do so and the results of these observations should therefore indicate if the flight distances had been permanently affected in the Unseen birds or if they would lessen to resemble those of normally reared birds as they became accustomed to the sight of human beings.

Each day the Experimenter also approached each group of birds in turn to determine if their responses in this situation changed with time. After the first ten days, when responses in the above situations had become fairly constant within each group the Experimenter approached the birds more closely by opening their cages and waving a hand directly in front of the birds. Finally the responses of all the birds to a novel object introduced into the home environment were observed. It was decided to use a novel stimulus that had previously been found to arouse very little fear or exploration so that there would be the greatest chance of detecting any changes caused by the Unseen rearing treatment in the degree of fear or exploration aroused by the stimulus. Although birds of 8-9 weeks of age had never been observed experimentally for their responses to a plastic windmill a pilot study showed that, in common with the mature and the 16-week old birds of experiment B 3, birds of this age reacted largely with indifference to this stimulus.

Materials and Methods

a. Transfer of birds to new "home environment" A period of 24h was allowed to elapse after the last bird was observed in experiment D 3 during which time the birds were not disturbed apart from the routine supplying of food and water. All sixty birds were then transferred from the rearing pen to another pen in the poultry house which was completely screened off visually. Within this pen was a cage unit, three cages high and four cages wide. Each cage had solid walls and measured 50 x 60 x 53 cm high. The fifteen birds of each stock-treatment class were split at random into three groups of five birds; this gave a total of twelve groups and each of these was allocated to one of the twelve cages according to a randomised block design. Open

food and water dishes were attached to the outside of the front of each cage. A table was placed 1.5 m opposite the front of the cages, apart from which the pen was empty. Artificial heat was no longer supplied and the birds were exposed to a 14h light - 10h dark schedule. The birds were transferred to the cages during the evening and in total darkness. The five birds for each cage were taken together in a cardboard carrying-box. They were left completely undisturbed for 36 h and then the observations began, on the morning of Day 1.

Observation procedure Observations were made on the birds at the same time every morning. One hour after each daily observation period and again each evening the food and water dishes were filled. This prevented them from ever becoming completely empty and minimised the chances of responses to the Experimenter being influenced by an anticipation of being fed. During the course of the experiment the pen was entered only at the time described above. The daily observation procedure was as follows:-

Part A Presence of Experimenter in pen Days 1-21

The Experimenter entered the pen and sat on the table opposite either the left or right side of the cage block. Each of the six cages in that half was observed in a predetermined random order, changed daily. At each observation, which lasted 20s, the position in the cage and activity of each of the five birds was noted. This was then repeated three times giving a total of four observations. The experimenter then moved to the other side of the table and repeated the entire procedure on the remaining six cages. The side to be observed first each day was randomised.

Since the birds' coloured leg bands were frequently obscured in these multi-bird cages, a count was made at each observation of the total number of birds occupying the front, middle and back portions of the cage. The numbers standing and lying were then counted; followed by the number eating or drinking preening,

dozing, huddling in a back corner or idle, by which was meant not engaged in any of the foregoing activities. A bird was judged to be at the front, or back, of the cage if there was not sufficient space between it and the cage wall for another bird to stand. As the birds grew it became physically impossible for all five birds in a cage to be simultaneously at the front or back thus birds in the middle, but facing the front or back and obviously trying to push in amongst the others were scored as being at the front or back.

Since the four observations made on each cage on each day were not strictly independent these four results were added together for the purposes of statistical analysis. Thus if, for instance, on any day for any one cage the results were

1st observation	1 standing	4 lying
2nd observation	1 standing	4 lying
3rd observation	2 standing	3 lying
4th observation	1 standing	4 lying

then the total score for that cage at Part A would be 5 standing and 15 lying.

Part B Experimenter stands in front of cage Days 1-21

Part C Experimenter places hand on cage Days 1-21

When Part A was completed for both sides of the cage block the responses of the birds to the closer proximity of the Experimenter was recorded. Following the same random order of observation as used in Part A the experimenter approached each cage in turn and, bending down where necessary, stood directly outside the cage for a period of 30s, looking into it and quietly recording the position of the birds in the cage (front, middle or back) and also the time at which any bird changed its position. This was observation B.

Immediately following this the Experimenter placed one hand on the centre of the cage front and again recorded the birds' positions in the cage during a 30s period - Part C. The Experimenter then returned to the table at the other side of the pen and stood there for 60s before proceeding to the next cage to be observed. From the observation records of Parts B and C the total time spent by all the five birds in each cage, out of a maximum of 150s , at the front, middle and back were calculated.

The procedures of Parts A, B and C were followed on each of the 21 days of observations in this experiment. However, after the first 10 days additional daily observations were made in the following way on days 11-15 inclusive:-

Part D Experimenter opens the cage Days 11-15

On completing Part C (hand on cage) the Experimenter opened the cage door and stood just outside it, looking in and recording the positions of the birds for 30s.

Part E Experimenter waves hand Days 11-15

On completing Part D the Experimenter waved a hand, in a circular "royal wave" at the entrance of the cage for 30s.

Part F Responses to novel object Day 16-20

During days 16-20 inclusive the observation procedure was further modified and the responses of the birds to a novel object introduced into the home environment was observed in the following way. On completing Part C the cage door was opened, a coloured, plastic toy windmill was attached to the centre of the inside walls and the cage door closed again. The Experimenter then stood a few paces back from

the cage and recorded the behaviour of the birds for a period of 120s, before removing the windmill. Birds were scored either as standing at the back of the cage (away from both windmill and Experimenter), or around the windmill, or at front of the cage (away from the windmill but relatively close to the Experimenter). Times spent fixating or pecking the windmill were also noted.

On day 21 observations A B and C only were made on each cage; thereafter no further observations were made.

Analysis of Results Statistical analysis was carried out on six separate groups of results which differed from each other in the five days during which the observations were made and in the type of observation. The six analyses were:-

1. Parts A B and C of Days 1-5 inclusive.
2. Parts A, B and C of Days 6-10 inclusive.
3. Parts A, B and C of Days 12-16 inclusive. These were the 5 days each of which was preceded by a day during which the cage was opened and a hand waved in front of the birds.
4. Parts D (cage open) and E (wave hand) of Days 11-15 inclusive.
5. Parts A, B and C of Days 17-21 inclusive. These were the 5 days each of which was preceded by a day during which the windmill was placed in the cage.
6. Part F (windmill) of Days 16-20 inclusive.

Thus each analysis contained the results of 5 consecutive days. There were three different cages containing birds of each stock-rearing class giving a total of fifteen scores (5 days x 3 cages) for each stock-rearing class in each analysis. The data did not meet the criteria required for the use of parametric techniques (Siegel 1956) thus both between-stock and between-treatment comparisons of scores were made with non-parametric tests, in this case the Mann-Whitney U-test.

Results The results will be presented as briefly as possible in the text with the aid of Figures. Detailed results are given in the Appendix.

1. Comparison of Seen and Unseen birds

Docile-stock Only during the first five days were there any significant differences between Seen and Unseen docile-stock birds as regards the proportion of birds at the front of the cage when the Experimenter was (A) present in the pen but not close to the cages (B) standing directly in front of the cages and (C) placed a hand on the cage. During these first five days the Seen birds were significantly more often at the front of the cages and thus closer to the Experimenter than were the Unseen birds. Further, although on days 1-5 some Unseen docile-stock birds huddled at the back of the cage, regardless of the proximity of the Experimenter, the few Seen birds which did so, huddled only when the Experimenter's hand was on the cage. There were never any significant differences between treatments as regards the numbers of birds standing, preening, walking etc. while the Experimenter was in the pen.

From days 6-10 onwards however the Unseen birds spent as much time at the front of their cages as did the Seen birds. There was from that time a daily average of ten to fifteen out of twenty docile-stock birds at the front of the cages when the Experimenter was in the pen (Part A); and they spent an average of 100-120s out of 150s at the front of the cage when the Experimenter stood in front of the cage and when a hand was placed on it. After day 6 birds of both rearing treatments put their heads out between the front bars of the cage when the Experimenter stood in front of it and had a hand onit, they also both pecked the hand. In most cases active attempts to approach the experimenter such as putting the head out between the front bars of the cage and pecking the hand were performed by

significantly more Seen birds than Unseen docile-stock birds.

During days 11-15 when the cage was opened (Part D) and a hand waved at the entrance (Part E) docile-stock birds of the two rearing-treatments had slightly differing reactions. The Seen birds spent significantly more time at the cage front than the Unseen birds. Birds of both types stepped out of the open cage, or fixated the moving hand, or retreated from it.

Responses to the windmill were very similar in docile-stock birds of the two rearing treatments. Most of them approached, fixated and then pecked the windmill and none panicked. A daily average of more than 200s (out of 600s) was spent at the windmill and of approximately a further 200s at the front of the cage, looking out at the Experimenter.

Flighty-stock Differences between the Seen and Unseen birds were much longer-lasting in the flighty stock than in the docile stock. When the Experimenter was (A) present in the pen, (B) standing directly in front of the cages and (C) placed a hand on the cage there were - throughout the entire 21 days of observation - a greater proportion either of Seen birds at the front of the cage and/or of Unseen birds at the back of the cage. In all but a very small number of cases these differences reached statistical significance. In both groups the daily mean number of birds at the front of the cage when the Experimenter was present in the pen (Part A) was always less than ten out of twenty; the greatest number of birds was nearly always in the middle of the cage. During days 1-5 birds of both groups huddled at the back of the cage when the Experimenter was present in the pen

but on following days none did so at this time. There were never any significant differences between rearing treatments as regards the numbers of flighty-stock birds standing, preening, dozing etc while the Experimenter was present in the pen (Part A).

When the Experimenter stood in front of the cage (Part B) and when a hand was placed on it (Part C) the Seen flighty-stock birds were fairly evenly distributed between the front, middle and back of the cage; whereas the Unseen birds always spent the greatest part of their time at the back of the cage, further from the Experimenter. During days 1-5 only, Unseen birds huddled at the back of the cage. From days 6-10 onwards some birds of both rearing groups put their heads out between the front bars of the cage and pecked the Experimenter's hand - but the numbers involved were very small.

During days 11-15 when the cage was opened (Part D) and a hand waved at the entrance (Part E) birds of both rearing treatments spent by far the greatest proportion of their time at the back of the cages. The Unseen birds spent significantly longer here than the Seen birds when the cage was first opened, but nearly all the birds of both rearing treatments were at the back during the whole time that the hand was being waved and there was thus no significant rearing difference at that time. No flighty-stock birds ever stepped out of the open cage. When the hand was waved birds of both types fixated it and some Unseen birds panicked.

There were no significant rearing differences in the responses of the flighty-stock birds to the windmill. The numbers approaching and pecking it were very small; rather more birds panicked. In both rearing groups the greatest proportion of the time during which the windmill was present was spent at the back of the cage, away from both the windmill and the Experimenter.

2. Comparison of flighty-stock and docile-stock birds

At all stages of the observation throughout the entire 21 days there were significant differences, within both rearing treatments, between the responses of flighty-stock and docile-stock birds. Either docile-stock birds spent significantly longer at the front of the cage than the flighty-stock birds or, flighty-stock birds spent significantly longer at the back of the cage than did the docile-stock birds. On some days both of these differences were significant.

There was also several instances of qualitative differences in the behaviour of birds of the two stocks. During several of the five-day periods it was only docile-stock birds which put their heads out of the cage when the Experimenter stood in front of it or placed a hand on it. Only docile-stock birds stepped out of the cage when it was opened and only flighty-stock birds panicked at the waving hand. However with a very few exceptions there were no significant stock differences in the number of birds standing, preening, walking, etc. when the Experimenter was present in the pen, away from the cages (Part A).

Birds of the two stocks behaved very differently in responses to the windmill. Significantly more docile-stock than flighty-stock birds approached and pecked it and docile-stock birds spent significantly longer beside it than did flighty-stock birds. Only flighty-stock birds panicked when the windmill was present in the cage.

A general point which should be made about the observations is that the position in the daily order in which each cage was observed did not seem to affect the birds' responses. Although this order was randomised to minimise any such effects a few comparisons were made between cages containing birds of the same stock and rearing

treatment but observed at opposite ends of the daily rota. No differences in responses which could be attributed to observation order were evident.

The following figures D 10-15, illustrate in histogram form the main stock and rearing treatment differences in response described above. The data are presented more fully in Tables D 21 A-D 30 A.

Discussion Rearing birds from hatching until 6 weeks of age without visual contact with human beings obviously affected the two stocks rather differently as regards their subsequent responses to human beings. In the docile stock the effects of the Unseen rearing treatment disappeared very quickly and it was only during the first five days that there were significant differences between Seen and Unseen reared birds with regard to the birds' positions in the cages at Parts A, B and C. The fact that the Unseen docile-stock birds moved towards the back of their cages even when the Experimenter was sitting some distance away indicates that the Unseen rearing treatment had in fact prevented the normal development of zero flight distances to Man and that this typical characteristic of docile stock birds was therefore not a purely innate one. Since it did appear to develop very rapidly once the birds had been exposed to human beings it is reasonable to presume that during normal rearing it develops equally rapidly at the time birds are first old enough to perceive human beings as a whole.

On days 11-15 when the Experimenter moved even closer to the birds the Unseen docile-stock birds again withdrew significantly more than the Seen docile-stock birds. There are several possible reasons for

F i g u r e D10

The daily mean ± SE number of birds (out of 20) or the daily mean ± SE times (out of 150s) spent by birds, at the extreme front and back parts of their cages at three different proximities of the Experimenter to the cage. Days 1 - 5.

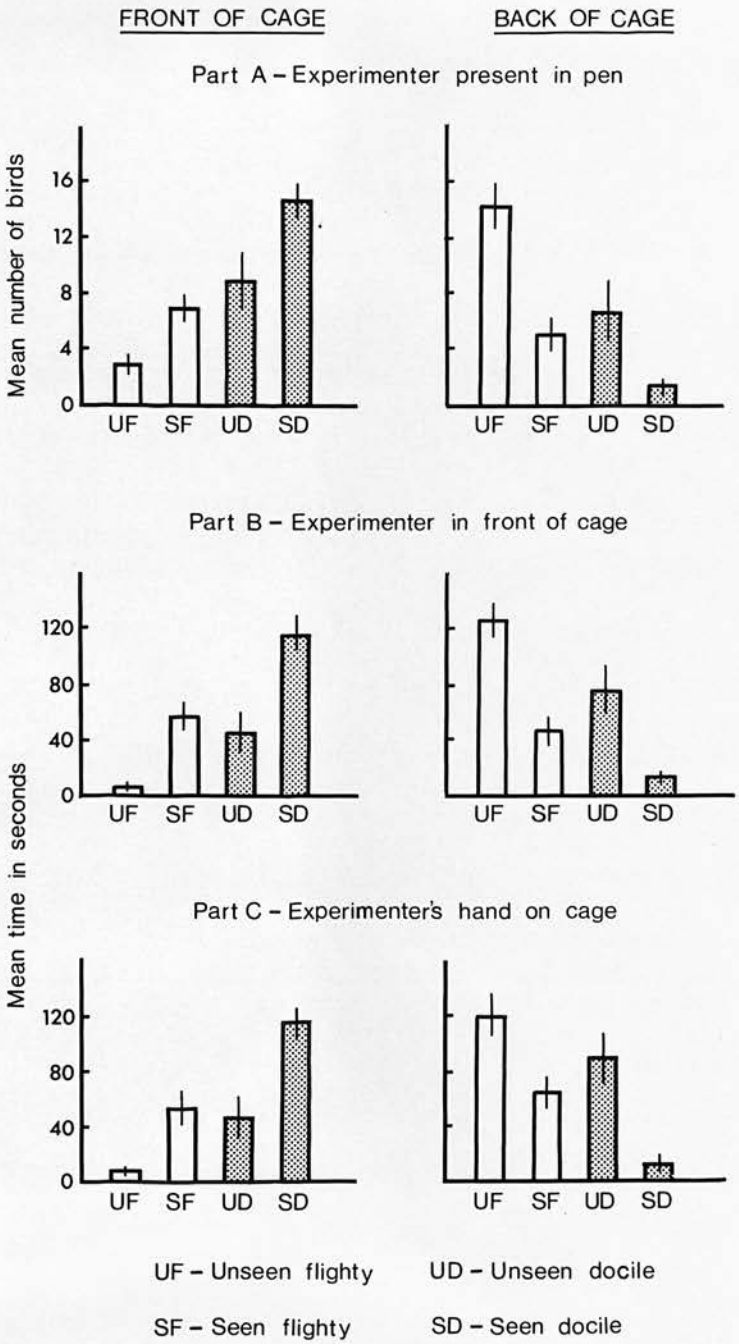


Figure D11

The daily mean ± SE number of birds (out of 20) or the daily mean ± SE times (out of 150s) spent by birds, at the extreme front and back parts of their cages at three different proximities of the Experimenter to the cage.

Days 6 - 10.

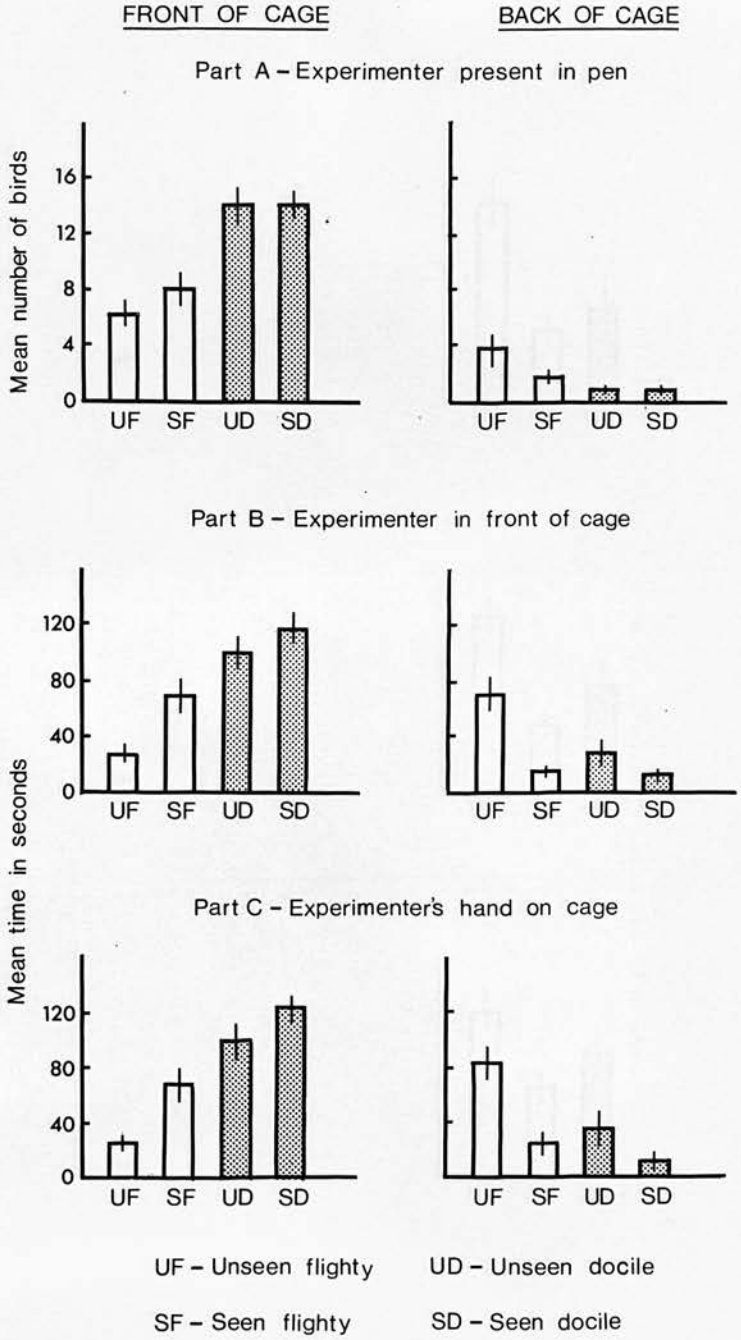


Figure D12

The daily mean ± SE number of birds (out of 20) or the daily mean ± SE times (out of 150s) spent by birds, at the extreme front and back parts of their cage at three different proximities of the Experimenter to the cage.

Days 12-16.

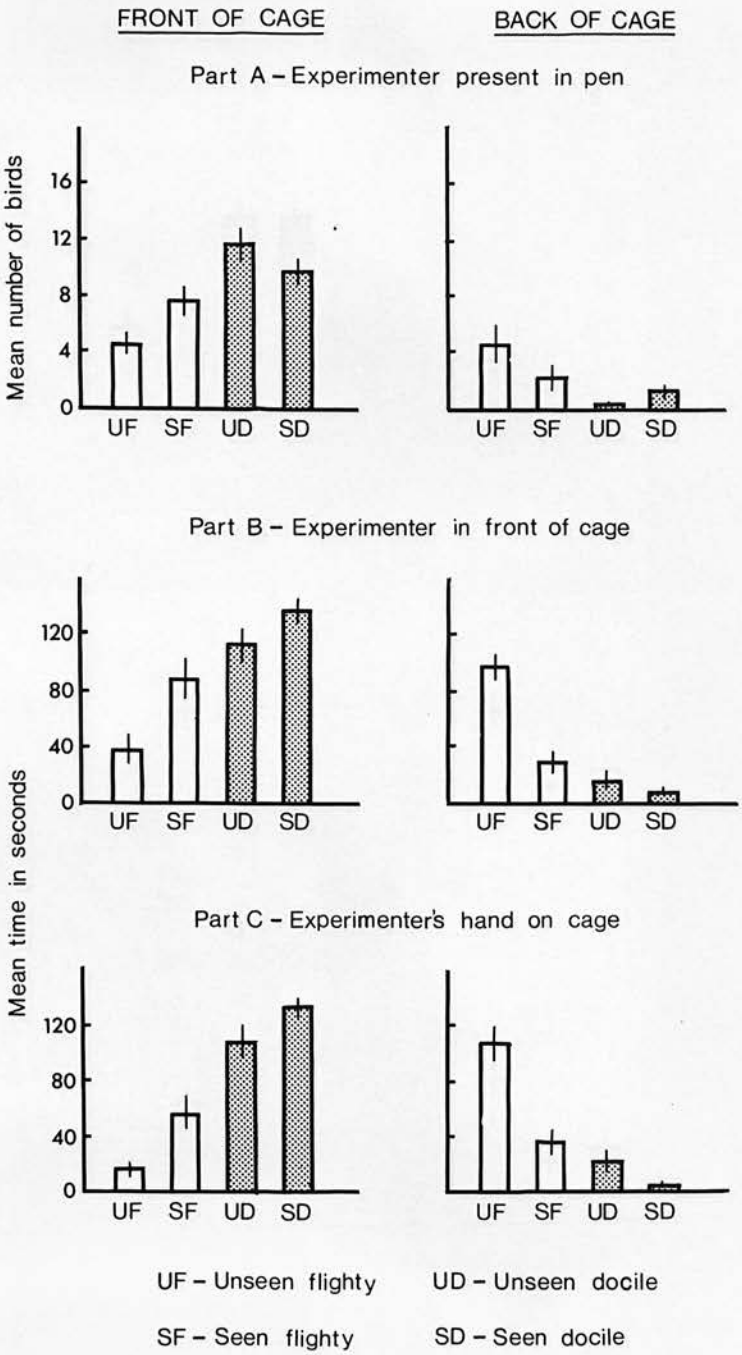


Figure D13

The daily mean ± SE number of birds (out of 20) or the daily mean ± SE times (out of 150s) spent by birds, at the extreme front and back parts of their cage at three different proximities of the Experimenter to the cage.

Days 17 - 21.

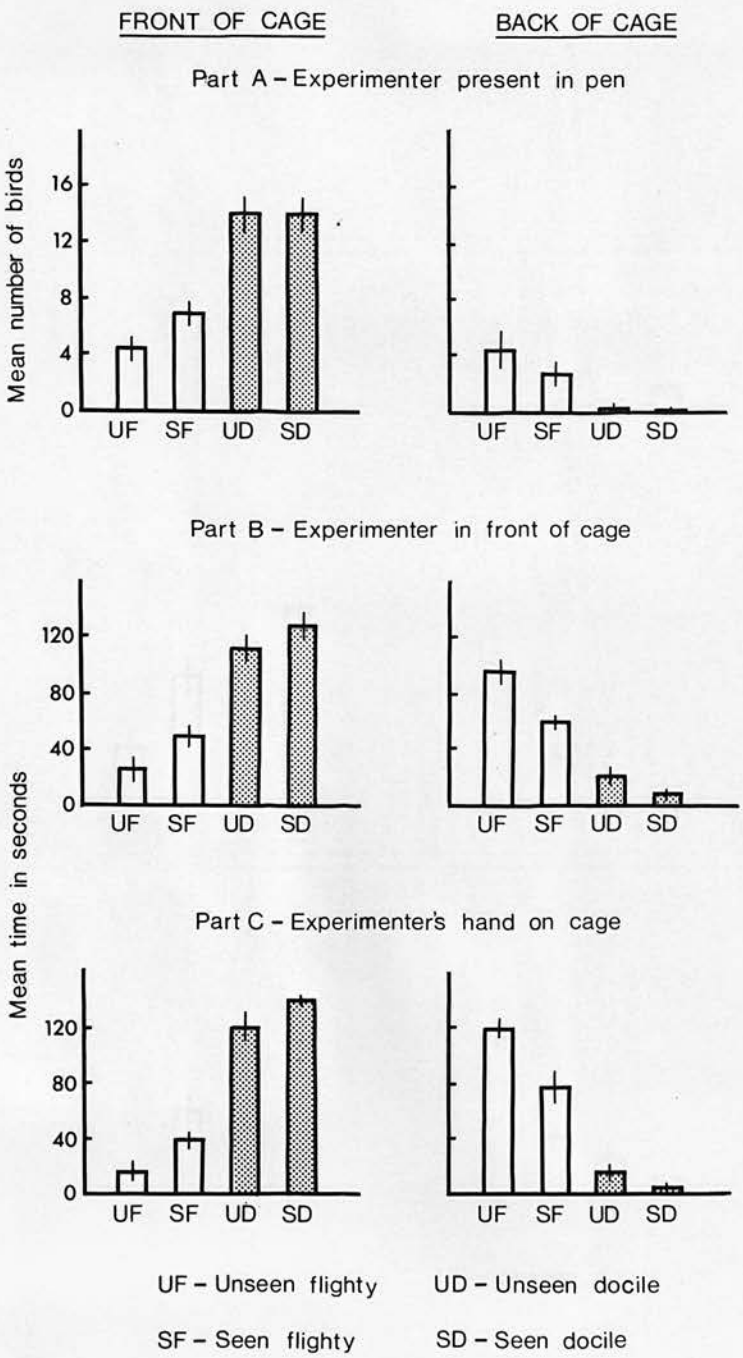


Figure D14 Exp D4

The daily mean ± SE times (out of 150s) spent by birds at the extreme front and back parts of their cages at two different proximities of the Experimenter to the cage.

Days 11 - 15.

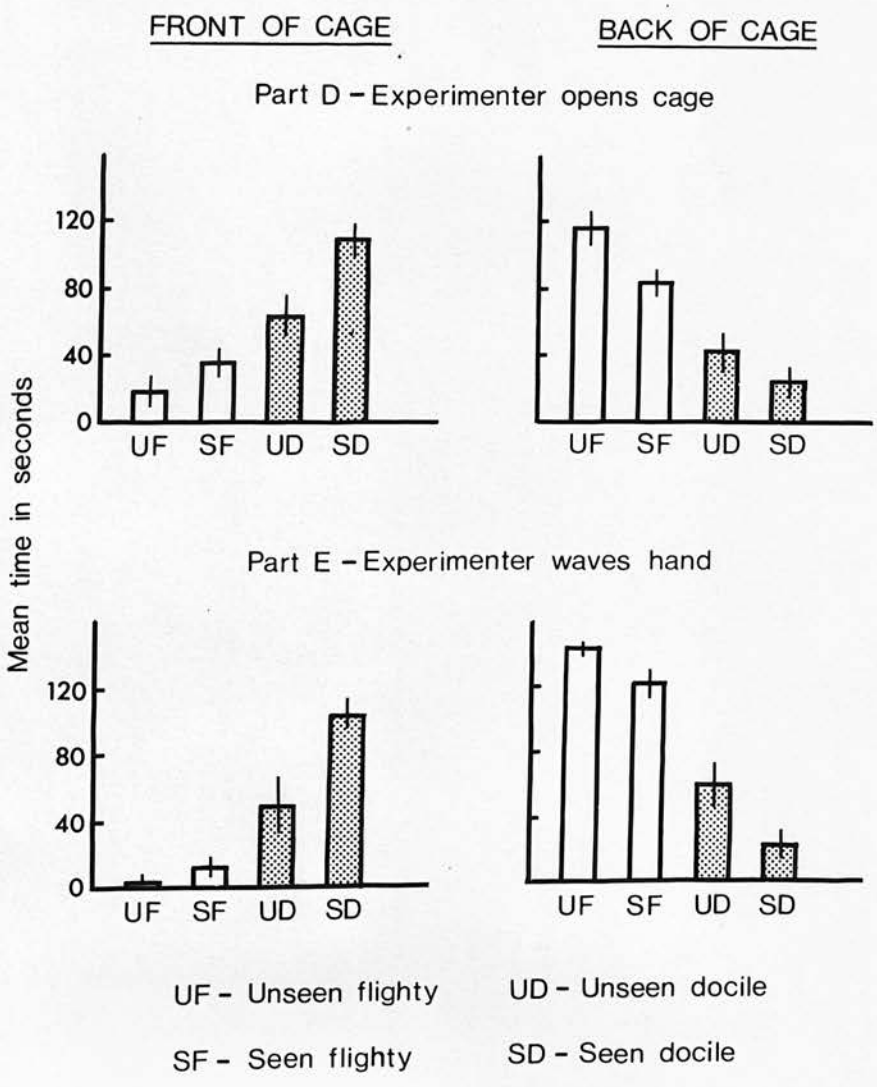
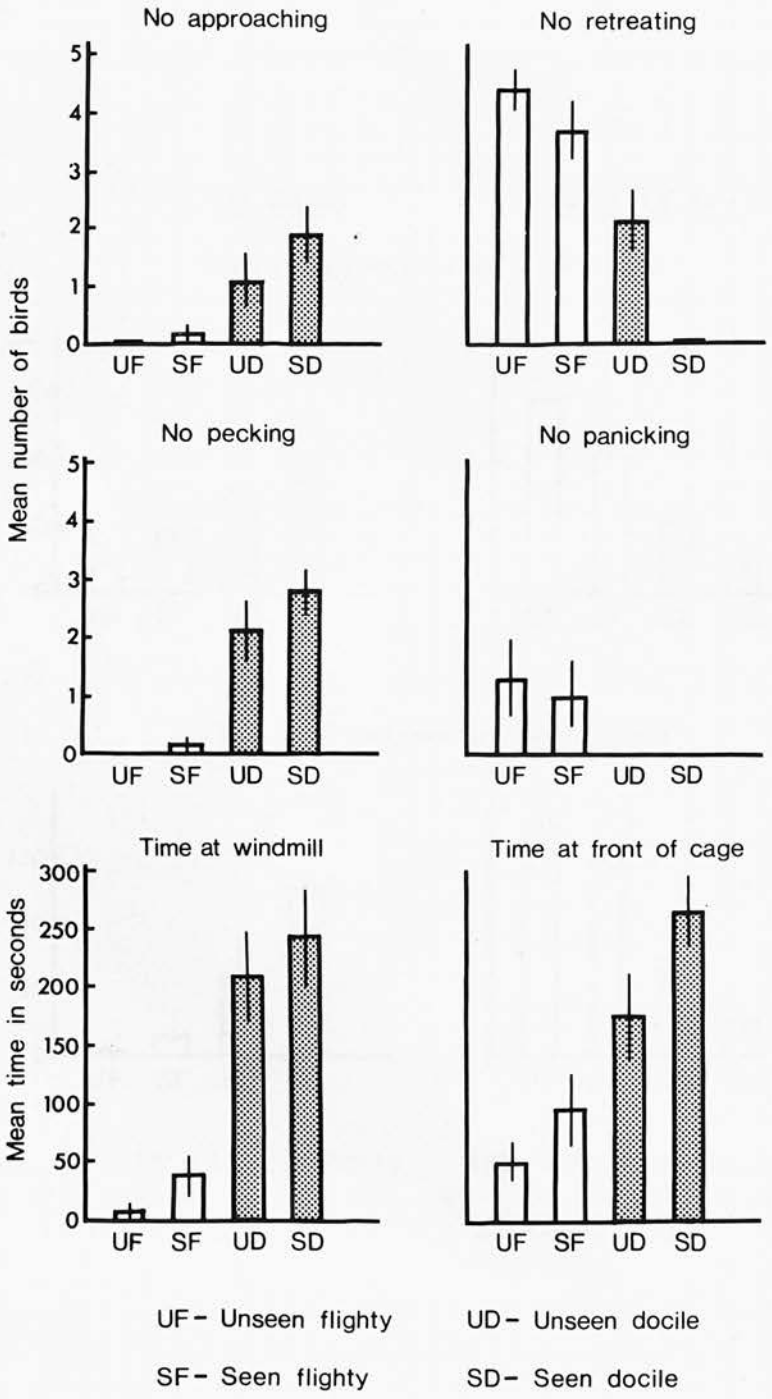


Figure D 15

The daily mean ± SE number of birds (out of 5) which approached or retreated from the windmill (during the first 5s only) and pecked it, or panicked (during the whole 120s); and the daily mean ± SE total time (out of 600s) per cage of five birds spent at the windmill or at the front of the cage.

Days 16 - 20



this. It may have indicated a very precise perception of flight distance; for the Experimenter was able to move a few centimetres closer to the birds when the cage was opened than when it was closed. Alternatively the birds may not have withdrawn because the Experimenter came too close but because they perceived the person without an intervening cage door as a different stimulus to the person behind the cage door; and the novelty of this "new" stimulus may have been sufficient to cause withdrawal. Indeed it may even have been the disappearance of the cage door that was instrumental in eliciting the withdrawal response. It is tempting to suggest that actual physical distance between a bird and a person was of minor importance here because the Unseen birds did not withdraw from the windmill which was placed even closer to them than the human being was. However since the two stimuli obviously differed in many other aspects, especially size, no definite conclusions of this nature may be drawn.

The only long-lasting effect that the Unseen rearing treatment had on the docile-stock birds was that they did not actively approach the Experimenter by putting their heads out of the cage or pecking the hand as often as the Seen birds did. This difference too might have lessened if the observations had continued longer than 3 weeks.

The Unseen rearing treatment had a much more permanent affect on the subsequent responses of the flighty-stock birds towards human beings. Throughout the 21 days they consistently showed even more withdrawal from the Experimenter than did the normally reared flighty-stock birds. However, apart from during the first 5 days, these differences were always much greater when the Experimenter was directly in front of the cage than when she was sitting 1.5 m away from it. Thus although there was, during the first five days, obviously some reduction

in the flight distances of the Unseen flighty-stock birds they did not - even after 3 weeks - lessen to anywhere near the level of those of the Seen flighty-stock birds. This rather large and persistent difference in flight distances between the Seen and Unseen flighty-stock birds indicated that although normally-reared flighty-stock birds show much more withdrawal from human beings than do normally-reared docile-stock birds, the flighty-stock birds have in fact undergone some degree of habituation of this response during rearing. A similar conclusion was reached after studying the results of experiments in Section B.

Responses to the novel object varied greatly according to stock but not at all with rearing treatment within either stock. This stock difference was rather surprising for, as described in the introduction to this experiment, a windmill had never before aroused the extent of exploration shown by the docile-stock birds or the extent of fear shown by the flighty-stock birds in the present experiment. A difference in experimental technique between the present and previous experiments, which could have been responsible for these discrepancies, was the actual positioning of the novel object. The present experiment was the only one in which a novel object was actually placed inside a bird's cage; even in the pilot study using birds of the same age the windmill was placed in the food trough outside the cage. Unfortunately the design of the cages in this experiment, the only ones available for birds of this size, meant that the windmill had to be placed inside the cages to prevent birds in adjacent cages from seeing it. The different responses shown by birds of each stock, dependent upon whether the windmill was inside or outside the cage and more especially the fact that these differences were in opposite directions, once more emphasises the extreme importance of what might possibly be regarded

as very minor details of a fear-provoking stimulus. This observation also supports one of the theories described above as explaining the withdrawal responses of Unseen docile-stock birds from a human being when the cage door was open; namely that they perceived the person with no door as a different stimulus to the familiar one of a person behind a door.

Having observed the birds in this experiment it seems certain that it was the closeness of the windmill which disturbed the flighty-stock birds. The relatively small size of the cage together with the fact that there were five birds in it meant that it was physically impossible for any bird to be more than a few centimetres away from the object. Indeed in the course of jostling one another while trying to push away from the windmill birds were often pushed right into it. When this happened, flighty-stock birds often responded by panicking, and this sometimes spread to the other four birds in the cage. This high intensity of withdrawal behaviour of the flighty-stock birds was similar to that shown by birds of this stock when a balloon was inflated inside the home cage (experiment B 4). Although it was then suggested that it was possibly the "approaching" aspect of the balloon which caused the withdrawal response the present results indicate that "enforced proximity to the stimulus object" may also be a relevant factor in the elicitation of withdrawal responses.

To conclude, the different rearing treatments did affect the responses of birds to human beings but did not appear to affect responses to a novel object placed in the home environment; there were slight differences in the responses to a strange environment but it was not possible to conclude whether these were directly attributable to the different rearing treatments or were the result of chance.

If the evidence of the literature is accepted that different degrees of "general stimulation" during rearing does affect later responses in "fearful" situations then the results of experiments D 3 and D 4, summarised above, testify to the non-unitary nature of "fearfulness" in the domestic fowl.

SECTION E

Introduction In this final section two groups of experiments are described which were necessary before any final conclusions could be drawn from the results of all the foregoing experiments. Firstly a comparison was made of the responses of birds of the two stocks to stimuli which occurred regularly in the poultry house, as a human being did, and which were expected to be fear-producing on the first occasion that a bird was exposed to them. Secondly some observations were made on the formation of the following response in young chicks. This was to help in evaluating the possibility that the lack of withdrawal responses from human beings characteristic of docile-stock birds was in some way connected to the formation of this response.

1. Responses to "fear-producing" everyday stimuli

Introduction One possible reason why flighty-stock birds, at all the ages observed, showed a greater intensity of withdrawal from human beings than did docile-stock birds is that birds of the flighty stock had a very much slower rate of habituation to this stimulus than did those of the docile stock. Experiments D 3 and D 4 have already indicated that under normal rearing conditions docile-stock birds undergo a very rapid habituation of this response. The following two experiments aimed to discover if flighty-stock birds showed a lesser degree of habituation than docile-stock birds to other initially fear-provoking stimuli to which the birds were regularly exposed.

The stimuli used were required to satisfy the following three conditions:-

1. They had to occur regularly in the poultry house so that it could be presumed that the birds' responses to them had habituated

as much as they ever would.

2. They must not be associated with the presence of human beings. If they were, stock differences in response would probably be inevitable.

3. They must be shown to arouse a high and as far as possible an equal degree of response in birds of both stocks on their first exposure to them - as was the case with a human being in experiment D 3.

Only two stimulus situations were found which satisfied these three conditions. They were (1) the production of a sudden loud noise and (2) the operation of the mechanical scraper in the battery unit.

Experiment E 1

Introduction

This experiment compares the responses of birds of the two stocks to a sudden loud noise of a type frequently heard in the poultry house. The noise was produced by dropping a metal bucket, from waist height, onto a concrete floor. Dropping buckets, metal food and water containers and banging the steel doors of the pens all made a similar noise and were all heard daily in the poultry house.

Experiment 1a investigates the responses of chicks on their first exposure to this stimulus; experiments 1b and 1c describe the responses of 10-week old and of mature birds respectively.

Experiment E 1 a

Materials and Methods Twenty chicks of each stock were observed at 8 days of age. After hatching they were kept individually in standard chick boxes in a sound-proof room where constant background noise was provided by the ticking of a clock. One hour before an observation was made one chick of each stock was transferred, in its box, to an adjoining sound-proof room with the same background noise. The boxes were placed on a bench 3 m apart and could be overlooked simultaneously. At observation time the Experimenter waited until both chicks were standing and either eating, drinking or pecking litter, and then the stimulus was presented. On hearing it all chicks crouched and froze. Thereafter they either suddenly stood up and became active, or gradually relaxed and appeared to "sleep". It was often very difficult to determine whether a chick was still freezing or had relaxed. Therefore, the only measure taken was the time that a chick stood up after the auditory stimulus had been presented and any chick which had not done so after 15min was given a latency of 15min for the purposes of statistical analysis.

The two boxes were sufficiently far apart to prevent the resumption of activity by one of the chicks being heard by the other. A maximum of four pairs of chicks was observed on any one day.

Results Chicks of the two stocks had very similar latencies to stand up after the auditory stimulus, the mean values being 603 ± 55.5s for the flighty stock and 605 ± 54.1s for the docile stock. In both stocks seven chicks had not stood up within 15min of the stimulus; in only two of these cases was this during the same observation.

Experiment E 1 b

Materials and Methods Sixteen birds of each stock were observed at 10 weeks of age. They had been exposed to the stimulus noise almost daily since hatching. The birds were normally housed in communal rearing cages where social ineractions would undoubtedly have prevented an accurate assessment of an individual's responses. Birds were thus transferred 3 days before observation to individual accommodation in a block of solid-sided cages placed directly beside the communal cages. Two birds of each stock were housed in these cages at any one time.

The Experimenter stood 2 m away from these cages, partially hidden by a wire mesh screen and when all four birds were observed to have been standing facing the cage front and not engaged in any obvious activity for at least 30s the stimulus was presented. The immediate response of each bird was noted. Two hours later another four birds were transferred to these cages and the entire procedure repeated until all birds had been observed.

Results There were no significant differences in the responses of the birds to the noise. One flighty-stock and three docile-stock birds crouched and froze; three flighty-stock and two docile-stock birds turned around, two of each stock startled; and ten flighty-stock and nine docile-stock birds showed no visible reactions at all.

Experiment E 1 c

Materials and Methods Eighteen battery-housed birds of each stock were observed at 9 months of age. They had been exposed to the stimulus noise almost daily since hatching. Half of the birds in each stock were in the centre row and half in the lower row of the battery unit.

Opposite stock birds were housed directly above or below one another.

Since birds in individual battery cages are not able to influence each other's responses by, for instance, running or flying into each other in the way that birds housed communally sometimes do, the birds of the present experiment were observed in their home cages. The Experimenter stood 1 m in front of the battery unit and 1.5 m along from the cages to be observed. When two birds, one above the other, were seen to be standing facing the front and had not been engaged in any obvious activity for at least 30s the stimulus was presented. The immediate response of each of the two birds was noted. A maximum of two pairs of birds were observed on any one day, separated by an interval of at least 4h. Observations were never made on more than two consecutive days.

Results On presentation of the auditory stimulus one bird of each stock startled; three flighty-stock and four docile-stock birds turned round; and fourteen flighty-stock and thirteen docile-stock birds showed no visible reaction.

Experiment E 2

Introduction The operation of the mechanical scraper in the battery unit is a procedure which was shown to cause great alarm in birds on their first exposure to it. (Experiment C 13). In the present experiment the responses of mature birds, after several months of exposure to the stimulus, was measured.

Materials and Methods Seventy two battery-housed birds of each stock were observed at 8 months of age. At the time of the experiment they had been housed in these cages for 4 months, during which time the

scraper had been operated on five days every week. The same procedure was used as for the younger birds (Exp. C 13). The scraper was passed along beneath the cages with the blades up and then returned with blades down: each bird's response was noted on the two occasions the scraper blade passed directly below its cage.
Observations were made on four different batches of birds, each containing an equal number of both stocks.

Results The birds reacted only slightly, if at all, to the scraper. With the exception of one flighty-stock bird which jumped up at the front bars of the cage there was no evidence of the alarm shown by the younger birds on their first exposure to the scraper. A total of sixteen birds clawed at the front bars: forty-five birds took one or two steps on the spot: thirty-four birds looked down through the floor at the passing scraper, and one hundred and ninety two birds showed no visible reaction at all. There were no significant stock differences in the type of response shown.
The data are presented in Table E 1 A.

Discussion of Experiments E 1 and E 2

The crouching and freezing responses of the chicks to the novel auditory stimulus were very pronounced, resulting in long inhibitions of normal activity. Kruijt (1964) described this response as typical of Jungle Fowl chicks on hearing a sudden loud noise and Phillips and Siegel (1966) made a similar report about domestic fowl chicks. It would therefore appear to be an unlearnt response pattern within the genus and is presumably of high survival value to the chicks. Contrary to the unlearnt response given to a novel approaching visual stimulus in experiments B 5 and B 6, the intensity of the responses given to the auditory stimulus in experiment E 1 were not

significantly different in the two stocks.

The 10-week old birds were mostly indifferent to the auditory stimulus and the mature birds almost completely so. The slightly greater responsiveness of the younger birds may have been attributable to age alone, or it may have been totally or partly caused by the fact that they had recently been rehoused. This procedure may have made them extra-sensitive to environmental stimulation of any kind; however for present purposes which of these factors applied was not of relevance.

Of much more relevance were the following findings on the responses of mature birds both to the auditory stimulus and to the mechanical scraper:-

1. Birds of both stocks had habituated to these two stimuli which aroused a very high intensity of response in nearly all birds on their first exposure to them.
2. Birds of both stocks appeared to have habituated to the same extent to each of the two stimuli.
3. Habituation was virtually complete. Almost all of the mature birds showed no visible reactions to either of the stimuli.

These findings indicate that the flighty-stock birds <u>were</u> capable of developing complete habituation in their responses to a stimulus (scraper) which initially caused as much, if not more, alarm than a human being did. In fact casual observations suggested that this habituation to the scraper normally occurs in both stocks in as short a time as 10 days, with one exposure daily. However since a human being and the mechanical scraper differ in almost every aspect it is not possible to conjecture, without a further series of experiments to separate the variables involved, why there should have been this almost complete habituation to one stimulus and yet hardly any to the other.

The absence of a stock difference in habituation to the scraper and the presence of one in habituation to a human being provides further evidence for the non-unitary nature of fear in the domestic fowl. For here are two very different stimuli which on first exposure produced very similar responses. These responses were however obviously not indicating any trait of "general fearfulness" for although, at least in the flighty stock, the response produced by one stimulus (the human being) was very resistant to habituation, the response produced by the other stimulus (the scraper) appeared to habituate very rapidly.

2. The "following response"

Experiment E 3

Introduction and Literature Review

In addition to the innate tendency to flee from approaching moving objects, most precocial bird species also have, at a certain stage in their life history, an innate tendency to follow a receding moving object. After some experience of following the first moving object that they encounter after hatching the following response is shown only to this object. In the natural state the stimulus object will of course be the parent bird, and under commercial conditions it is other chicks.

The establishment of this following response is part of the process termed imprinting. It has been extensively studied under experimental conditions, some of the main areas of investigation being:-

a. The nature of the stimulus properties in terms of size, shape, colour etc which evoke following.

b. The degree to which the following response, once established, will generalise to similar stimulus objects.

c. The length of time after hatching that the following response may be evoked - the so-called "critical period".

d. The length of time that a chick must be exposed to the stimulus object for the response to become established.

A very large literature exists on the subject of imprinting. Since the following experiment forms only a very small and subsidiary part of the present study a detailed survey of this literature will not be included. Sluckin's (1972) book is recommended as an excellent review of the subject.

The phenomenon of imprinting is however of relevance to the present study for two main reasons:-

1. It appears that it is only within a definable period after hatching that a stimulus object will evoke the following response - usually about one to three days. The end of this "critical period" coincides with the onset of withdrawal responses shown by precocial chicks and the two events have been causually connected. The independent development of withdrawal responses has been suggested as responsible for the subsequent non-appearance of the following response if it has not already been established. Conversely the independent establishment of the following responses to one particular stimulus has been suggested as responsible for the subsequent appearance of withdrawal responses to all other stimuli. Earlier experiments in the present study have shown that flighty-stock chicks showed a higher intensity of withdrawal responses than did docile-stock chicks to at least one category of stimulus - a novel and approaching object - at this age. Thus since there is evidence in the literature, albeit conflicting in its nature, that withdrawal responses and following responses are in some way related, a comparison of the latter event in the two stocks was made to see if this might be in any way related

to the stock difference in withdrawal responses.

2. As mentioned above, some degree of stimulus generalisation occurs in the elicitation of the following response. It is possible that docile-stock chicks generalise to a much wider range of stimuli than do flighty-stock chicks, perhaps even to the extent of imprinting onto human beings as well as onto other chicks. If this were so it would provide a further possible explanation for the much lower level of withdrawal responses shown by docile-stock birds of all ages towards human beings; for although the following response itself wanes as a chick matures a lack of fear of the imprinting object remains. Experiments D 3 and D 4 showed that docile-stock birds which had no visual contact with human beings for the first 6 weeks after hatching, showed, after a few days of exposure to them, as little fear of human beings as normally reared birds showed. While this finding strongly suggests that any "classic imprinting" onto human beings did not normally take place in docile-stock birds it was, for reason (1) above, still felt to be of value to study the following responses of newly hatched chicks.

Standard laboratory studies of the following response involve exposing a newly hatched chick to a moving stimulus object, the training session, during which time the chick may or may not actually follow the model. The extent to which the chick has established a following response is then assessed by measuring its approach and following tendencies towards the moving object on a subsequent exposure some hours later, the testing session. Control chicks receive no training period. A procedure of this type was used in the present experiment. During the period between the training and testing sessions half of the chicks were given the opportunity to follow other chicks to

determine whether or not they would subsequently follow the test model to the same extent as chicks which were kept in isolation before testing. In other words this would determine if socially reared chicks would establish following responses to two different stimulus objects.

Subjects and experimental design

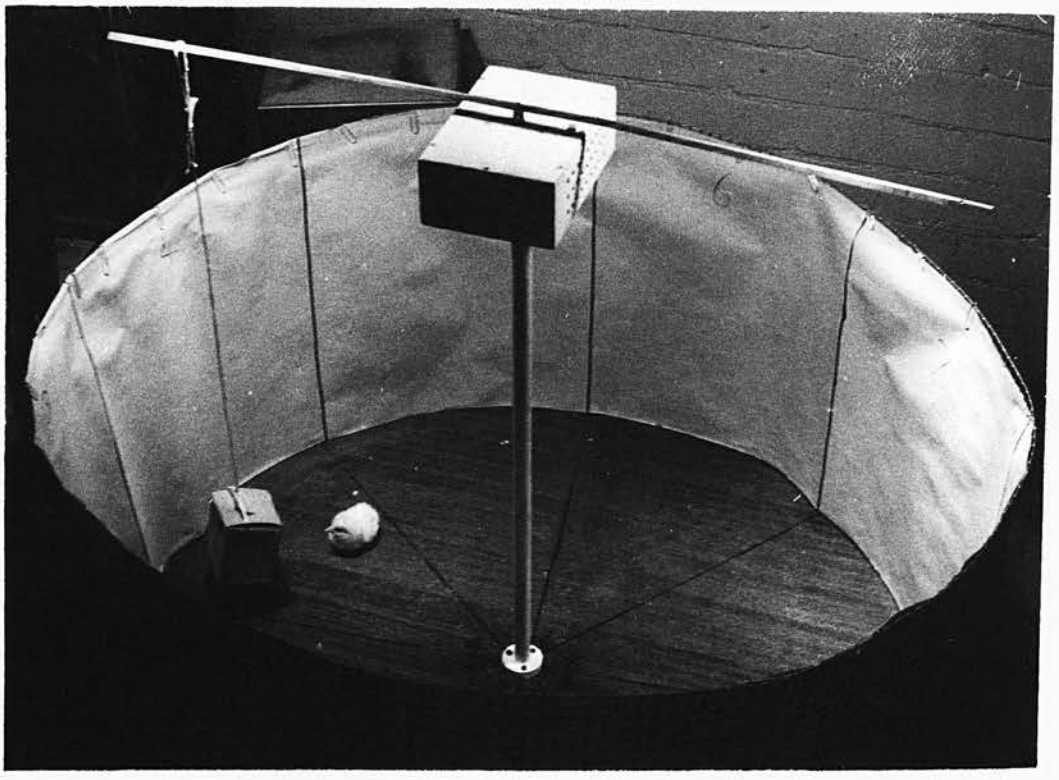
A total of sixty-four chicks of each stock were used. Within each stock the chicks were assigned at random to one of four groups, each having sixteen chicks. There were two experimental treatments, trained and not-trained and two rearing treatments, reared singly or reared in pairs. Together with the two stocks this gave a 2 x 2 x 2 factorial design.

Materials and Methods

a. Incubation and Hatching Eggs, all at the same developmental stage at the start of incubation, were incubated at a temperature of 37.5-38°C and a relative humidity of 85-88%. On the eighteenth day of incubation they were candled and those containing live embryos placed individually in perforated cardboard, hatching boxes measuring 75 x 75 x 65 mm. At noon of the 21st day of incubation the boxes were examined; any chicks which had already hatched and dried were not used in the present experiment. At 7pm on the same day the boxes were again examined; only those chicks which were then dry were used. Thus the maximum difference in ages between the chicks in this experiment was 7h. Each of these examinations required approximately 1min to complete all the boxes. Since the fluffy down was easily visible through the perforations in the boxes it was not necessary to open them at this time. At 11am on the following morning the boxes were removed from the incubator and taken

Plate 10

The apparatus used to establish a following response in newly hatched chicks.



to the main poultry house. They were placed under 275 watt bulbs where the temperature was the same as in the incubator and the light intensity high - 1500 lux.

b. The imprinting runway The runway was circular, 71 cm in diameter, and made of varnished plywood. The floor was divided by thin black lines into eight equal sections. The walls, 70 cm high, were covered on the inside with white paper. A central support stand, 2 cm in diameter, held a small electric motor in position 70 cm above the floor. The motor, which operated almost silently, turned an arm from which the imprinting model was suspended; this was a box 75 x 75 x 65 mm painted half green and half red. It traced a circular path with the base 5 cm above floor level and 10 cm from the wall of the runway so that a chick could easily pass between the wall and the model. The model made two revolutions of the runway each minute.

Two 275 watt bulbs were suspended 88 cm above the floor of the runway and kept the temperature here constant at around 37°C. A black cloth screen was placed beside the runway behind which the Experimenter sat and observed the chicks from above, over the top of the screen. The runway was kept in a pen on the main floor of the poultry house. It is illustrated in Plate 10.

c. Training procedure Chicks were trained between 1 pm and 4 pm on the day of removal from the incubator. Each chick was carried, still in its hatching box to the runway.where it was removed from its box and placed next to the central stand facing out across the runway. The Experimenter held her hand over the chick's head as it settled and then removed it slowly. The Experimenter then retired behind the screen and after 15s the stimulus model began to move. Its starting position was always 45° to the left of the position the chick was facing and it travelled clockwise past the chick. Since the chick did not normally move during the training procedure the

model was revolved continuously for 10min (ie twenty revolutions) thus ensuring maximum exposure of the model to each chick. After 10min the model was stopped and the chick removed.

Chicks which were not trained with the model were left alone in the empty runway for 10min. Between training and testing the chicks were kept either singly or in pairs in standard chick boxes. There was nothing either red or green, the colours of the model, in these boxes.

d. Testing procedure Chicks were tested between 1 pm and 4 pm on the day following training, if any. The procedure was essentially identical to that during training with one important difference. The model alternately moved for 1min, two revolutions of the runway, and was then stationary for 1min. Many chicks followed the moving model continuously and stopping it ensured that the onset of tiredness did not interfere with the following response.

During both training and testing all the activities of each chick were noted and timed on a portable tape recorder.

During the time that one member of a pair was being trained or tested a "companion chick" of the same age and stock was placed in the rearing box beside the remaining chick. These companion chicks were not observed in the runway.

Analysis From the observation records the following were calculated for each chick during both training and testing:-

1. Latency to approach model.
2. Latency to follow model.
3. Times spent standing, lying, with eyes closed and beak on ground.

4. Total time spent standing beside the stationary model (testing only) - "stand with model".

5. Total time spent following the moving model - "follow model".

6. Total time spent with model. The sum of 4 and 5 above - "total with model".

7. Total time spent standing still or lying, but not beside the model - "stand from model".

8. Total time spent fleeing from the model - "flee model".

9. Total time spent moving, but neither following after or fleeing from the model - "random move" or "moving at random".

N.B. The sum of times 4, 5, 7, 8 and 9 accounted for the entire observation period.

10. Total time spent in central area of runway - "at centre".

11. Total time spent in pathway of model or 5 cm to either side of it - "at path" or "in model's path".

12. Total time spent at wall of runway.

N.B. The sum of times 10, 11 and 12 accounted for the entire observation period.

13. The number of sections through which the chick followed the model. (Maximum possible = 160. training and 80 testing).

14. The number of sections through which the chick fled from the model.

15. The number of sections through which the chick moved at random.

16. The total time spent peeping.

17. Total incidences of the following (i.e. less than 5s duration).

a. Chasing model. Frequently while following the model a chick would become distracted and peck at the floor, then it would suddenly look up and, seeing the model at the other side of the runway run straight to it.

b. Pecking model. Each individual peck made was counted.

c. Fixating model. Staring at the model and following its movement

with the head and neck as it passed.

d. Attacking model. Jumping up at the model, pecking it vigorously and adopting a very stiff, upright posture.

N.B. The term is used as a descriptive basis only and does not imply underlying causation.

e. Peeping, pecking the environment, pecking own feet, preening, performing comfort movements, yawning, defaecating, and jumping at the walls.

Results

Training Although at the time of training none of the chicks had seen other chicks, the statistical analysis was carried out with those chicks which were to be reared singly treated as a separate group to those which were to be reared in pairs. Obviously, no differences were expected between these two groups during the training session.

All of the sixty four chicks, except ten, moved about in the runway during the training session, but the number which actually followed the model was relatively small, eighteen. More docile- than flighty-stock chicks approached the model ($p < 0.001$) and more followed the model ($p < 0.05$). The low incidence of following was undoubtedly due partly to the poor locomotor ability of the chicks at this stage. Nonetheless most of the chicks (fifty six) fixated the model at least once as it passed.

There was some competition for the chicks' attention from their own feet which they frequently watched and even pecked. Many chicks also pecked at the ground, often at matter which they themselves had just defaecated. Although most of the chicks did move around in the runway the mean times involved were very small, the range for the four classes being from 15.0 ± 3.5s to 64.8 ± 34.2s. There was little

evidence of distress in the form of jumping at the walls, but a total of fifty two chicks spent some time peeping.

There was only one significant difference concerning the numbers of chicks which were to be assigned to a single or a paired rearing treatment. More chicks which were to be reared singly performed comfort movements than did chicks which were to be reared in pairs. ($p < 0.001$). In addition to the significant stock difference in the number of chicks which followed the model more docile-stock than flighty-stock chicks spent some time with eyes closed ($p < 0.001$) and more flighty-stock than docile-stock chicks defaecated ($p < 0.01$).

The analysis of variance detected these additional significant differences. Single chicks fixated the object on more occasions than did paired chicks ($p < 0.01$); flighty-stock chicks, while moving at random crossed a greater number of sections than did docile-stock chicks ($p < 0.05$) and flighty-stock chicks spent longer peeping than did docile-stock chicks ($p < 0.001$).

The data for the training session are presented in Tables E 2 A and E 3 A.

Testing Out of the three variables of stock, rearing and training, that of the rearing method had by far the greatest effect on the behaviour of the chicks towards the model during the testing session. Regardless of stock or training experience, more chicks reared singly, as opposed to in a pair, approached the model ($p < 0.001$), stood with the model while it was stationary ($p < 0.001$), spent time in the model's path ($p < 0.001$), followed the model ($p < 0.001$) and pecked the model ($p < 0.001$). Also, more of these chicks performed comfort movements ($p < 0.001$) and pecked the environment ($p < 0.001$). More of the chicks kept in pairs spent some time lying than did chicks reared alone ($p < 0.05$).

For those behaviour patterns in which the numbers of chicks involved were not significantly different the analysis of variance detected the following differences between rearing teatments. Chicks reared singly, as opposed to chicks reared in pairs, had shorter latencies to approach the model ($p < 0.001$), and they crossed a greater total number of sections (i.e. following + fleeing + random moving), $p < 0.001$. Chicks reared in pairs spent longer than those reared alone standing away from the model ($p < 0.001$), in the central area of the runway ($p < 0.001$) and peeping ($p < 0.01$).

Significant differences between the two stocks were much less frequent. More flighty-stock than docile-stock chicks spent time at the wall of the runway ($p < 0.001$) and more docile-stock than flighty-stock chicks chased the model ($p < 0.001$), fixated the model ($p < 0.01$), and pecked the environment ($p < 0.05$). Flighty-stock chicks spent longer than those of the docile stock moving at random about the runway ($p < 0.05$), and docile stock chicks spent longer than those of the flighty stock in the model's pathway ($p < 0.01$).
The effects of training were also relatively slight. There were no significant differences at all in the number of trained and untrained chicks which performed any of the behaviour patterns observed. The analysis of variance showed that trained chicks had shorter latencies to approach the model ($p < 0.01$), and spent a greater total time (standing beside + following) with the model ($p < 0.05$) than did untrained chicks. Trained chicks also pecked the environment more often ($p < 0.05$), and performed comfort movements more often ($p < 0.05$). Untrained chicks, as compared to trained ones, spent more time peeping ($p < 0.05$), crossed a greater number of sections while moving at random ($p < 0.05$), and also a greater total number of sections ($p < 0.05$).

The number of significant interactions between the main effects was very small. There was a rearing x training interaction in the

incidences that the environment was pecked ($p < 0.05$), and also in the incidences of comfort movements performed ($p < 0.05$). In both cases this was because the pair-reared chicks showed no variation with training whereas those reared singly did.

The data are presented in Tables E 4 A-E 6 A.

Discussion During the training session more docile-stock than flighty-stock chicks followed the model. This might have been attributable to a greater locomotor ability of the docile-stock chicks, but since those of the flighty stock actually crossed a greater total number of sections this is not a very probable explanation. It appeared therefore that docile-stock chicks had a greater tendency than those of the flighty stock to approach and follow this first moving object they encountered after hatching. Of course without using a variety of objects of different shapes, sizes and colours and obtaining the same result it is not possible to reach any general conclusions about this stock difference. The possibility also exists that, since there were no significant stock differences in any of the other measures concerning the model, the difference in the numbers approaching and following was a chance one. Chance was almost certainly responsible for the single significant difference (comfort movements) that occurred between chicks to be reared in groups and those to be reared in isolation.

During the testing session chicks which had been trained approached the object sooner and stayed with it longer than did untrained chicks, suggesting that the training period had in fact been effective. However the presence or absence of another chick between the two sessions was of much more importance in determining the amount of following shown to the model. Those subjects which had been able to follow another chick showed very little subsequent following of the model.

Guiton (1959) and Sluckin and Salzen (1961) similarly found that chicks reared in visual isolation from others followed a model better than did those reared in a social group. In the present experiment the period of exposure to another chick (24h) was of course much longer than that to the model (10min). But this is the same order of difference in times that chicks are normally exposed to other chicks and to a human being during the first days after hatching. It thus seems unlikely that under normal rearing conditions, socially-reared chicks are forming attachments to human beings which may be described as the classical following response or as imprinting.

There was an almost total lack of any stock difference on any of the measures concerning the model during the testing session. Docile-stock chicks did chase the model more often, but this in fact indicated that they had been more often distracted and stopped following. The results of this experiment therefore suggest that although the establishment of the following response and the development of withdrawal responses are in some way related, the stock differences which have been found in withdrawal responses, are not attributable to differences in the formation of the following response.

GENERAL DISCUSSION

The experiments in this thesis have been concerned with the behavioural expression of fear and exploration in two stocks of domestic fowl. Previously, fear in this species has been studied almost exclusively in connection with its role in the imprinting process in young chicks. The great majority of work on exploration has also been concerned with the elucidation of the stimulus situations which will cause chicks to approach and follow. Even a brief examination of the published literature on fear and exploration in any species is enough to show that the effectiveness of any stimulus and the types of responses shown are influenced by a large number of variables and that it is sometimes not immediately obvious whether a particular response should be regarded as fearful or exploratory.

Therefore it was decided that it would be of most value to carry out a very broad survey covering as wide a range of stimuli as possible and including birds of all ages. It was presumed that this would identify those particular areas of research which it would then be most beneficial to follow and those which should be avoided in order to come to a more full understanding of fear and exploration in the domestic fowl. Thus a large number of experiments were carried out, not all of which are reported in this thesis, and a large volume of data has been collected. The results have verified many times over that this was a useful approach, for there were many instances in which the narrow approach of studying one stock, one age and one experimental situation would have led to a false interpretation of the results. The findings are discussed below under some of the major headings used in the literature review.

Firstly however a summary is given of the answers to the questions posed in the Introductory Section. Each question has already been

discussed at depth after the relevant experiments. It will be remembered that birds of the white stock were renamed as flighty-stock birds and those of the brown stock as docile-stock birds.

1. What was the precise nature of the stimuli which would elicit the flighty response in the white-stock birds?
It was not possible to determine the exact nature of the stimuli involved, although it was established that more than one stimulus, or combination of stimuli, would elicit the response. Factors such as size, distance between stimulus and bird, whether stationary or moving towards or away from the bird, and novelty, were all relevant and interacted with each other in a complex manner.

2. At what age did the flighty response pattern first appear?
Withdrawal responses could be elicited in chicks as soon as they were physically able to perform them.

3. Did the brown-stock birds ever exhibit the flighty response, and if so under what conditions?
The flighty response was shown by chicks and by 16-week old brown-stock birds to a novel and approaching stimulus; by 16-week old birds on their first exposure to the mechanical scraper; and by 6-week old birds on their first exposure to a human being. There were some instances in which the intensity of withdrawal responses shown was equal in the two stocks and several in which it was greater in the white-stock birds, however there was only one instance of a greater intensity of withdrawal being shown by brown-stock birds.(experiment C 13).

4. Could the response be modified in its intensity or even completely abolished in the white-stock birds?
It was not possible to significantly reduce the flighty response of white-stock birds to human beings, compared to the responses of control

birds, by associating a human being with a food reward. Rearing birds without human contact for the first 6 weeks after hatching resulted in birds which showed this response at an even greater intensity than did normally reared birds.

5. Did birds of the two stocks differ in any other aspects of their behaviour which may have been related to and/or accounted for the differences in flightiness shown towards human beings?

While the flighty responses shown by brown-stock birds appeared to habituate fairly rapidly during early life and showed evidence of generalising to include other stimuli by maturity, white-stock birds never habituated completely to the stimulus of a human being. However they did habituate as rapidly as the brown-stock birds to other stimuli, including sudden loud noises and the operation of the mechanical scraper. Their lack of habituation to human beings was thus obviously not caused by any lack of ability to form a habituation of responses. Observations on the following responses of chicks, and of birds reared until 6 weeks of age without contact with human beings provided evidence that the lack of a flighty response to human beings, typical of brown-stock birds was probably not in any way connected to the phenomenon of imprinting. The flighty responses to human beings, typical of white-stock birds, could not be explained in terms of this stock being more generally fearful or emotional than the brown stock; for in some situations birds of both stocks appeared equally afraid (inflating balloon and mechanical scraper at 16 weeks of age) and in yet others the brown-stock birds showed more signs of fear (novel food at 9 weeks and 8 days of age and novel objects placed in the home environment at 5 months of age).

Fear stimuli

A wide range of stimuli was found to be capable of evoking fear in the domestic fowl. It included a strange environment, a novel and approaching stimulus, stationary novel objects and even food of a strange colour or consistency. The conclusion of other authors such as Gray (1971) that no single stimulus property is common to all fear-evoking stimuli was confirmed.

It is not possible to state categorically that a certain stimulus is or is not fear-evoking in the domestic fowl. It was found for instance that a stimulus which produced responses indicative of fear in birds of one age did not necessarily do so in birds of the same stock but a different age (an inflating balloon in experiment B 4) and that a stimulus which produced responses indicative of fear in birds of one stock did not do so in birds of the same age but a different stock (a coloured windmill placed in the cage in experiment D 4).

In this study time did not permit that different stimuli could be compared as regards the amount of fear they produced. But it was established which stimuli did and which did not produce fear responses, an important step before proceeding to compare stimuli. There are at least two methods which may be used to compare fear stimuli and both have many restrictions on their use. One method is to compare the effectiveness of different stimuli in inhibiting a response produced by a conflicting drive such as hunger. Thus one could compare the relative times that feeding is inhibited by the fear produced by the presence of a human being, the operation of the mechanical scraper or the production of a sudden loud noise. To achieve valid comparisons, all the birds involved would of course have to be equally motivated to eat and, as experiment C 12 showed, the various methods of measuring feeding motivation in the domestic fowl are not related in a linear

manner. Another difficulty is that exploration may successfully compete with feeding (experiment C 14) and birds may stop feeding, not because of fear of a novel stimulus, but because they are exploring it. The time that feeding is inhibited will thus not be an accurate measure of the amount of fear experienced. It is also probable that while a high degree of fear inhibits feeding a lesser amount may in fact facilitate it; the feeding serving to reduce the amount of fear experienced. Eating, or drinking is well known to reduce fear in human beings and there is no reason why it should not have the same effect in other species. Incidental observations on birds during the first week that they were exposed to the mechanical scraper, and on each day showing less signs of fear of it, indicated that feeding was an almost universal response after the machine had stopped, although the birds were not hungry at this time.

A second method of comparing fear stimuli involves their effects on a fearful response rather than on one from another motivational state. The technique usually employed is to produce a fearful response, say peeping in an Open Field, and then observe and compare how other fear stimuli, say giving an electric shock or increasing the light intensity, affect this response. An obvious danger here is the interpretation of the direction of the change in the peeping response. The experiments of this study, in common with others cited in the literature review, show peeping and the amount of fear it expresses to have a complex relationship. Thus although for instance, electric shocks were found to increase peeping and a bright light to decrease it, it would not necessarily follow that shock was a higher intensity fear stimulus than light. If a response were available which varies directly with the amount of fear experienced this would be a useful technique for comparing various stimuli within individual animals. The "tonic immobility response" seems to fall into this category. This response has been extensively studied in the domestic fowl by Gallup and co-workers

(see Gallup 1974 for review) and is believed to be an innate fear response released on being seized by a predator. However since the production of the response involves approaching and handling birds, the existence of very large stock differences in responses to human beings prevented the use of this response in any comparison of the two stocks.

A restriction which applies to both of the above methods of comparing fear stimuli is that, because of the non-unitary nature of fear in the domestic fowl any comparisons of stimuli made in one situation cannot be generalised, without further experiments, to other situations. In other words if it were found, for instance, that an electric shock was more effective than a bright light in inhibiting feeding, it could not be presumed that shock would also be more effective in prolonging the immobility response. This point is expanded in a later part of this discussion.

The recognition of fear responses

It is not always immediately obvious from the behaviour of a domestic fowl that it is afraid. Of course some responses such as running away from a strange stimulus object, pacing along the walls of a strange enclosure, or emitting certain vocalisations are usually immediately regarded as indicative of fear. Taking the example of pacing in a strange environment, it might be argued that this pacing may be motivated by anger, boredom or frustration rather than by fear. However this type of argument, if carried to its logical conclusion, could be applied to almost any situation. It could also be argued, and at least in the case of human beings it is certainly true, that feeding and fighting are sometimes motivated by boredom rather than by hunger or aggression. The accurate interpretation of any behavioural response

must therefore involve consideration of the situation in which it occurs. If an animal has been starved for several days and is then given food, it is fair to assume that its feeding is motivated by hunger; if food is available ad libitum and the home environment totally lacking in any form of sensory stimulation then some feeding almost certainly will be motivated by boredom.

It was concluded in the literature review of Section C that the fear system has evolved to enable animals to avoid or escape from predation or other dangers. If then, an experimental animal is presented with a stimulus situation such as a strange environment or being approached by a strange object, stimuli which in the natural habitat would represent potential danger, and that animal responds to reduce or remove that danger, or to warn conspecifics of its presence then I believe there is every justification for classifying that response as fearful. The difficulty is that animals kept in the laboratory or under commercial conditions, are often thwarted in their attempts to perform "natural" fear responses. An example from the present study concerns the experiments in which hungry birds were presented with a novel food. Under natural conditions, if fear of a novel food inhibited feeding a bird would presumably move away and search for a more familiar source of food. Since this response could not be performed by birds in cages with no other potential food source, the conflict between the fear of the food and hunger resulted in the performance of a displacement activity such as lying down and dozing. This type of response, the performance of a "normal" behaviour pattern performed as a displacement activity is not so easily recognisable as indicative of fear as is running away from the strange food. It is however usually possible to establish that such "normal" behaviour patterns are being performed as displacement activities by comparing their performance in the supposedly

fearful situation with that in the undisturbed home environment. Knowing then, that hungry birds when given their normal food do not lie down and go to sleep it was possible to classify the sleep shown by birds given a strange food as indicating the presence of fear.

In the case of chicks confined to a strange environment and prevented from performing the natural fear response of leaving that environment, fear was expressed by the adoption of body postures, standing with beak on ground and sitting, not normally shown by chicks undisturbed in their home environment. Here again without a good knowledge of the chicks' normal behaviour, these postures would not have been regarded as meaningful. On this basis it is essential, whatever species is being studied, that the undisturbed behaviour of animals in the environment in which they are normally kept is thoroughly familiar to anyone intending to study the responses of these animals in a supposedly fearful situation.

To summarise, if a domestic fowl is presented with a stimulus representing potential danger and it responds

a. by performing a response that reduces or removes that danger

or

b. if a response of type (a) is prevented by the characteristics of the environment in which that bird is kept, but the bird either performs a "normal" behaviour pattern out of context or performs an "abnormal" behaviour pattern,

then that bird may be regarded as responding fearfully. If none of these responses occur and the bird continues to behave as it was before the stimulus was presented, then it may be assumed that the stimulus was not sufficiently intense to arouse fear.

Of course in the case of placing an animal in a strange environment, it is not possible for it to continue behaving as before. Should then its behaviour, whatever it is, be regarded as motivated by fear? It is impossible to give a general answer to this question. In dealing with a wild animal in its natural habitat and finding itself in a strange part of it, after fleeing from fire or a predator the answer would almost certainly be yes - at least for the first few minutes that the animal was in the strange environment. In dealing with species such as the domestic rat or domestic fowl which have been subjected to hundreds of generations of artificial selection and in which there has been no selection pressure for survival by performing such natural fear responses it is not justifiable to take it for granted that fear will be aroused. Only by observing an individual's behaviour and determining if it falls into either category (a) or (b) above, can this behaviour be regarded as indicative of fear. It was on this basis that standing completely still, making small head movements and presumably listening was classified as a fear response in older birds isolated in a sound proof room. Under natural conditions such a response would probably be of high survival value.

The ranking of fear responses

It was obvious from the start of this study that the ranking of fear responses would be a major difficulty and it was one reason why it was decided to study two stocks rather than just one. It was common knowledge amongst all who had worked with these two stocks that one was more flighty, or appeared more afraid, than the other in their responses to human beings. Differences in other situations were thus expected and this was very desirable for one cannot rank fear responses if all the birds respond in the same way.

Various methods are commonly used which are presumed to manipulate the amount of fear which an animal experiences. Any differences in response are then taken to represent correspondingly high or low amounts of fear. Some of these methods are discussed below.

1. The "novelty" theory This theory, supported by King (1966) and Bronson (1968 b) defines fear purely in terms of novelty and presumes that the more novel a stimulus is, the more fear it will evoke. Alternatively, equal amounts of novelty are presumed to produce equal amounts of fear. At a very general level this theory is probably valid, but there are restrictions on its use. On this basis it would for instance be assumed, that a bird normally housed on a solid floor and in dim light would experience the same amount of fear if placed on a cage floor and in bright light as would a bird of the same strain and age, exposed to the reciprocal procedure. Equal amounts of novelty are involved in the two situations but, as experiments in this study showed, a change from solid flooring to a mesh floor inhibited the birds' movements in a way that a change from a mesh floor to a solid floor did not. This inhibition of movement might obviously influence the expression of fear responses to all the other strange aspects of the environment and unless taken into consideration result in a false interpretation of these responses. In other words, the novelty theory suffers from the great disadvantage that it takes no account of the sensory capacities and natural habitat of the animals being studied in presuming how much fear a particular stimulus can be expected to elicit.

The conditions under which experimental animals are kept are often chosen for their suitability to the experimenter, the technical staff or even the institute accountant rather than for their suitability

to the animals. It is thus possible that one particular environmental change imposed on an animal may elicit fear on account of its novelty but will not elicit any on account of its particular physical aspects because these reflect the species "natural" conditions. Another strange environment however, may elicit fear both on account of its novelty and its physical characteristics.

An example in which differences in sensory capacity meant that presumed equal amounts of novelty in a stimulus were in fact not equal concerns comparisons made between albino and pigmented mice in Open Field tests (for review see Goodrick 1973). Mice of the two strains responded differently and this was at first attributed to different levels of fearfulness in the two strains to the same stimulus. However it was later realised that mice of the two strains were not equally sensitive to light and were thus not in fact being exposed to the same strange environment. Mice are hole dwellers and light a strong aversive stimulus, thus the albino mice were being exposed to a much greater intensity of fear stimulus than were the pigmented mice and it was this, rather than differences in basic levels of fearfulness that the different responses reflected.

To summarise, if the sensory capacities and natural habitat of the species, and the home environment of the particular subjects in question are considered; then it should be possible to assess which of several changes in environment would produce the greatest amount of fear. This procedure was used in the present study in predicting that a completely silent environment would produce more fear than one with the accustomed level of background noise. Since it is unlikely that different home environments provided by Man will be equally suited to a particular species the novelty theory should not be used to presume that reciprocal changes in environment will induce equal amounts of fear.

2. Repeated testing - more or less fear? Another much used method of supposedly manipulating the amount of fear produced is to respeatedly expose an animal to an Open Field test at intervals of anything from a few minutes to several weeks. The underlying assumption is always made that fear of the Open Field will decrease on each occasion that the animal is exposed to it. Authors have then been concerned with whether more rapid decreases in fear occur with short or with long inter-trial intervals (Candland, Culbertson and Moyer 1965); whether all presumed measures of fear such as incidence of defaecation and amount of ambulation decrease at the same rate (King and Appelbaum 1973, Broadhurst 1958 a, Valle 1971): whether fear and exploration of the strange environment both decrease at equal rates (Russell and Williams 1973); or whether equal rates of decrease are shown by animals at different ages (Broadhurst 1958 a, Valle 1971, Bronstein 1972, 1973).

But is it always correct to assume that the more often an animal is exposed to a fearful situation the less afraid it will be? Is it not equally reasonable to assume that if an animal experiences fear on the first occasion that it was placed in a strange environment it may experience even greater fear on the second or third occasion. It is easy to anthropomorphise and say that the animal will "remember" that nothing dreadful did happen on the first occasion and that it was eventually returned to its home environment, but we have no evidence for this. And, if analogies with human experience may be made, does one necessarily feel any less afraid when entering the dentist's surgery for a second visit just because one eventually "escaped" after the first one? And what of phobias? It is commonly accepted that these fears do not diminish and in fact may even increase, with repeated exposure. Therefore extreme caution must be used before assuming that repeated testing in a strange environment will of necessity result in reduced fear. This is particularly important if repeated testing is to be

used as a technique for producing and ranking the relative intensities of different fear responses.

3. Alternative methods In some cases, as in experiment C 5, when chicks of different ages and rearing treatments were used it was possible to suggest after logical argument, which of two or more responses was the most fearful. In other cases there was no way of determining from a bird's behaviour its relative state of fear, although it may have been tempting to try and do so. For example, when a stimulus object was placed at the front of a cage a bird which turned and ran to the back of the cage and jumped up at the bars squawking was presumed to be more fearful than one slowly backing away. But just how valid is such a presumption? It would definitely be valid to say that the first bird showed withdrawal or avoidance responses of a greater intensity than did the second bird but this is not necessarily the same as saying that one is more fearful than the other. Perhaps much of the ambiguity and confusion surrounding "fear" would disappear if more accurate descriptions of behaviour were always used rather than the vague term fear. Unfortunately in those situations in which fear is expressed by the performance of a normal behaviour pattern as a displacement activity there is really no suitable substitute for "fear".

In view of these difficulties of recognising and ranking fear responses it is questionable whether a bird's behaviour should ever be used to try and assess the fearfulness of an individual. If other methods were available, which gave such easily and quickly obtainable information and provided it more accurately, then the observation of behaviour would probably become redundant. Physiological changes and their results are the obvious candidates here, but as outlined in the Introductory Section the physiological measurement of fear

poses easily as many problems as it solves. The measurement of internal change in heart rate and blood pressure requires delicate equipment and technical knowledge which severely limit its application. The measurement of external changes in for instance, pupil size, comb colour and feather posture can only be measured by a human observer at a very crude level; in the case of changes in pupil size the problems involved in observing this response in a flighty-stock bird are obvious.

There is almost certainly scope for the recognition and measurement of fear in older birds by a detailed examination of the vocalisations of the domestic fowl, of the type carried out by Baeumer (1962). After several years of work with this species it is apparent that vocalisations play an important part in the birds' daily lives. Undoubtedly the most accurate method of studying fear involves a combination of observations on behaviour, physiological changes and vocalisations. However at the present state of knowledge, much more information on each of these measures is still required before their interactions can be usefully studied.

In conclusion then it became increasingly obvious while performing these experiments that one cannot make general statements either about what constitutes a fearful response in the domestic fowl, or about how much fear a particular response is likely to represent. For instance in a totally strange environment, a silent chick is probably more fearful than a peeping one, whereas in the home environment a peeping chick is probably more afraid than a silent one; when in a strange environment from which there was no escape, mature birds which moved around a lot were interpreted as being in a relatively high state of fear but when given free access to a strange environment

it was those birds which moved around the most which were believed to be the least afraid. Each fearful situation must therefore be viewed separately and defined by the age of birds, their past experience and the fear stimulus being used. General statements to the effect that, for instance, "birds express fear of a strange environment by pacing along its walls" are best avoided, for they do not take into account the facts that if one of the strange aspects involved is silence, or a change from a solid to a mesh floor, pacing may be inhibited and fear expressed by standing still.

There is no reason why it should only be in the domestic fowl that fear responses are so dependant on external variables and therefore the restrictions on defining fear behaviour which have been discussed above should be borne in mind whatever species is being studied.

The non-unitary nature of fear

The greatest danger in using the single word fear is that it gives the impression that a unitary system is involved and indeed many obviously believed this to be the case. Bindra and Thompson (1953), Anderson (1938) and Billingslea (1941) all compared the responses of rats exposed in turn to a variety of presumed fear-provoking situations which included incidences of Open Field defaecation, latency to emerge from the home cage and responses to the Experimenter. They all presumed that a positive correlation should be shown between each individual's relative degree of fear in one situation and that in each other situation. In other words they were supposing that fear was unitary - that one could state that this animal was more fearful than that one and that this would be true in any fear-producing situation. But as Montevecchi, Gallup and Dunlap (1973) demonstrated this is not usually the case. Assuming that the

tonic immobility response of chicks expressed fear they found ways of increasing, by pre-test exposure to loud noise, or decreasing by administration of a tranquillising drug, the intensity of this response. They then exposed chicks to these same procedures before placing them in an Open Field situation and measuring the amount of peeping shown. The various pre-test manipulations did not all have the same effects on peeping as on immobility, indicating that these two responses were not governed by the same underlying motivation.

The results of the present study also provided ample evidence that fear is not unitary. While flighty-stock birds appeared more fearful than docile-stock ones of a novel and approaching object birds of the two stocks appeared equally afraid of a sudden loud noise and docile-stock birds were more afraid than flighty-stock birds of a strange food. Completely different rates of habituation were shown to stimuli (a human being and the mechanical scraper) which on initial exposure produced almost identical responses. All of these facts point to inaccuracy of the word fear as a blanket term except when it is wished to refer to all of the behaviour patterns occurring within this system, as opposed to those of another system such as aggression.

The Open Field Test

This test which Hall and countless others believed to be a suitable tool for measuring individual differences in fearfulness or "emotionality" in the rat was not found to be so suited for the domestic fowl. It was proposed that a situation of this type produced such intense fear in fowls that any individual or stock differences were obscured. Further, experiments C 6, C 7 and C 9 demonstrated that strange environments evoke exploration as well as fear and that unless the animal is able to enter and leave the strange environment at will

there is always a risk that responses will be wrongly interpreted. One of the few other studies which has observed domestic fowl in an Open Field was that of Candland and Nagy (1969). They found a higher than expected incidence of defaecation and concluded that chicks, like rats, would defaecate when afraid. No such abnormal incidence of defaecation was found in the present study in birds isolated in a sound-proof room, the closest equivalent to a standard Open Field test used in the present study, but there was a high incidence of defaecation amongst chicks left in their home boxes after removal of a companion. It was therefore concluded that although the incidence of defaecation and the presence of fear may be related in the domestic fowl, the relationship is complex. The large differences between rodents and domestic fowl in the structure of the gastro-intestinal tract mean that any differences concerning the defaecation response are not unexpected.

Exploratory stimuli

Domestic fowl, in common with other species, were found not only to fear novel objects but also to explore them. The same type of restrictions which apply to the definition of fear stimuli also apply to those eliciting exploration. In other words, stock, age and individual were all effective variables in determining whether or not a particular stimulus would be explored. From the results of experiment C 11 it appears that a wide range of stimuli are effective in eliciting initial exploration but that only certain properties, such as how easily a bird is able to tear off parts of an object with its beak, are effective in eliciting further exploration.

Exploratory responses

The exploratory responses shown by domestic fowl in the present study agreed with Berlyne's (1960) general classification into orienting, locomotory, and investigating responses. The orientation response, which in birds takes the form of visually fixating an object, was especially prevalent. Exploratory responses were found to be much less variable in expression than fearful responses. In fact visual fixation, pecking and walking around were the only exploratory responses observed in birds of all ages.

Bearing in mind the definitions of Hinde (1970) and Hughes (1968) - see page 80 - which relate an exploratory response to a particular stimulus present in the environment, it is apparent that exploratory responses cannot be thwarted in the same way that fearful responses may, because the animal cannot escape from that environment. An exploratory response is, by definition, directed towards a stimulus, while a fearful response is usually directed away from the arousing stimulus. Thus the arousal of exploration does not tend to result in the performance of displacement activities in the same way that the arousal of fear has been found to do.

However there is one particular difficulty in observing exploratory responses in the domestic fowl which must apply to all species of birds. This is the fact that although pecking may be motivated by exploration, it may also be motivated by hunger or by aggression. Komai and Guhl (1960) have commented upon the unreliability of pecking as a measure of aggression in the domestic fowl. Since however aggressive responses are by definition directed against other birds it is unlikely that aggression and exploration should ever be confused. Much more difficult is the distinction between exploration and feeding

since both will be involved in a bird's pecks at a novel source of food. A detailed examination of the motor components of the pecking, as was done in experiment C 14, should however indicate when the initial cautious exploratory pecks have stopped and rapid feeding pecking with the actual ingestion of food has begun. But what of the situation which occurred in experiment C 11 when mature birds consumed large quantities of silver foil and of foam rubber? The birds were not hungry in the sense that they had not been deprived of food; their normal food was available but they chose not to eat it. Since this pecking was therefore not motivated by hunger, it was defined as exploratory pecking, even though consumption occurred.

When the stimulus being explored is a discrete object there is little difficulty in determining which of two birds explored one stimulus more, or which of two stimuli was explored more by one bird. All that is involved is measuring the amount of time spent fixating and pecking that object. Since different types of information are conveyed to a bird by the performance of the two responses I do not think it valid to say that one response represents a higher intensity of exploration than the other and on this basis compare the exploratory tendencies of different birds. Rather it should be said that bird A showed more visual exploration of the object, but bird B showed more tactile exploration of it. Similarly, when the stimulus being explored is a strange environment, it is not possible to compare quantitatively the exploration of a bird which moves around a lot with that of a bird which stands still but is obviously looking and listening.

Younger birds (Hinde 1954) and younger mammals (Bronstein 1972, Glickman and Sroges 1966) have been found to show more exploratory

behaviour than older ones but this was not always the case in the present study. Both chicks and 9-week old birds showed very little exploration of a novel food, whereas mature birds did explore it thoroughly. It is however very difficult to accurately compare exploratory tendencies at different ages, for not only is there the usual problem of equating motivation at different ages, but exploratory tendencies are often inhibited by fear and fear also varies with age; indeed it was proposed that it was a high level of fear rather than a low level of exploration which accounted for the behaviour of the younger birds in the experiments mentioned above.

The relationship between fear and exploration

It was found that most of the novel stimuli used, at all ages, evoked both fearful and exploratory responses. The responses always tended to alternate, as for instance fixating the novel object and jumping up at the walls (chicks in experiment C 15), entering and leaving the strange corridor (mature birds in experiment C9). There was never an occasion in which there was a single graduation from fearful to exploratory responses or vice versa. This is taken as evidence for the theory that fear and exploration are separate motivational systems rather than lying at opposite ends of a single system.

The fact that the same stimulus can evoke both types of response does not of necessity mean a single motivational system is involved. It is commonly accepted that a single stimulus may evoke both fear and aggression, fear and sex, or sex and aggression. Nor does the fact that certain responses, such as walking around in a strange environment, may be motivated by either fear or exploration preclude the possibility of separate motivational states. As discussed above the pecking response in birds is known to be motivated by

three district motivational states. Of course neither of these arguments actually prove that fear and exploration are separate motivational states; but does the fact that the two response types frequently alternate mean that they could not represent a single state and therefore must be separate? The answer must be that it does not, for a temporal alternation between high and low intensities of response are known to occur in other behaviour systems, particularly in sexual behaviour.

The experiments of this study provided no conclusive proof either for the theory that fear and exploration have separate underlying motivational states or for the theory that there is a single motivational state with the two types of response lying at opposite ends. My own belief is however that the typical rapid alternation between one response type and the other favours the view that fear and exploration have separate underlying motivations. But, as discussed in the literature review of Section C, I strongly feel that such theoretical arguments are of little value in contributing to our knowledge of how animals behave when afraid, a problem which is surely of more immediate importance.

Fear and exploration in the domestic fowl

What then, in summary, have the experiments in the present study contributed to knowledge of fear and exploration in the domestic fowl? I think the most important factor is the realisation that all the behaviour patterns commonly referred to as representing "fear behaviour" are not unitary. Some of the evidence used in coming to this conclusion has already been mentioned earlier in this discussion. This idea is in direct opposition to the theory held strong for many years that, in the domestic rat, emotionality or fear is a single trait (Hall 1934 b, Anderson 1938, Parker 1939, Billingslea 1941).

In fact, based on the performance of rats selectively bred for high or low defaecation scores in an Open Field test, in other so-called fearful situations, this belief in the unitary nature of fear has enjoyed continued support (Broadhurst 1969, Denenberg 1969 and Gray 1971). However the experiments described here show that in the domestic fowl, it is definitely not justifiable to make general statements to the effect that strain A is more fearful than strain B. Each situation in which comparisons are to be made must be treated separately and defined in terms of, at least, the age of the birds used and the fear producing stimulus. Similar arguments apply to exploration.

In this context of the non-unitary nature of fear it is relevant to note that those aspects of fearfulness, or rather a lack of fearfulness, which are desirable under commercial conditions were not positively correlated in the two stocks studied. Thus while the flighty-stock birds were generally unpleasant to work with, and may as outlined in the Introductory Section, suffer economically undesirable repercussions as a result of their flighty behaviour, they were also the most adaptable in their responses to a new source of food. The observation that the docile-stock birds, both as chicks and at 9 weeks of age, refused to eat for several hours at this time could be of economic significance.

The discovery that fear often resulted in the performance of a normal behaviour pattern as a displacement activity, has important implications in the field of animal welfare. A lack of overt fear responses such as pacing or alarm calling should not be taken complacently as indicative of a lack of fear of a particular husbandry practice. It is in this more practical area of research that I think further work on

on fear in the domestic fowl should be concentrated, rather than on aspects of more theoretical interest such as whether a chick peeps more often when placed in a box with vertical or horizontal stripes on the walls. The present experiments have shown that the domestic fowl is extremely sensitive to changes in its environment and, both from an economic and a moral viewpoint it is essential that its responses to such changes should be accurately recognised and classified.

The use of the word fear

In conclusion, it is suggested that use of the words "fear", or "fearful" to imply any general trait of temperament or personality in the domestic fowl is to be avoided. The terms "fear system" or "fear behaviour" and also "exploratory system" or "exploratory behaviour" may be used to describe the broad spectrum of stimulus-response contingencies which birds use to perceive and to subsequently avoid or investigate actual or potential sources of danger or of materials which may be of use as food, or shelter, or in other ways. Fear stimuli and fear responses should also not be defined in general terms but in terms of the situation in which they occur.

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A P P E N D I X

Tables of experimental results

Table I 1

Exp I 1

Behaviour of chicks observed undisturbed in the home environment for 2h.

Results of the analysis of variance of the main effects (stock and age) and their interactions, on the times or incidences of performance of the behaviour patterns listed below.

SOURCE OF VARIATION	STOCK		AGE		STOCK x AGE	
DEGREES OF FREEDOM	1		2		2	
	VARIANCE RATIOS					
Time spent:						
Standing	3.86		2.55		2.16	
Beak on ground	0.39		11.54	***	0.42	
Eyes closed	0.79		12.93	***	0.63	
Eating	0.38		5.18	**	1.51	
Drinking	0.87		0.49		0.36	
Preening	4.12	*	4.83	**	0.13	
Pecking litter	1.63		4.99	**	3.16	*
Idle	0.63		1.83		0.62	
Incidences of:						
Change stance	14.86	***	2.52		4.02	*
Defaecation	0.97		0.90		0.63	
Peck environment	0.67		0.12		3.09	*
Preen	1.24		0.85		1.60	

Residual degrees of freedom = 66.

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table I 2

Exp I 1

Behaviour of chicks, reared in visual isolation, observed undisturbed in the home environment.

The number of chicks in each stock-age class which, during a 2h observation, performed each of the behaviour patterns listed below. There were no statistically significant differences due either to stock or age, (χ^2 Test with Cochran's (1954) modification).

N = 12 in each class.

STOCK	WHITE			BROWN		
AGE IN DAYS	4	7	14	4	7	14
Time spent:						
Standing	12	12	12	12	12	12
Lying	12	12	12	12	12	12
Beak on ground	12	12	12	12	12	12
Eyes closed	12	12	12	12	12	12
Eating	11	11	11	11	12	12
Drinking	11	9	10	11	12	12
Preening	12	11	12	12	12	12
Pecking litter	12	11	12	10	10	11
Pacing	1	3	4	3	2	1
Dust bathing	0	1	6	0	0	4
Peeping	0	3	3	3	0	0
Incidences of:						
Change stance	12	12	12	12	12	12
Peck Environment	10	11	11	11	11	9
Defaecation	11	12	12	11	11	12
Comfort movement	11	12	12	11	11	12
Preen	11	12	11	11	12	11
Jump at wall	10	7	5	5	6	6
Yawn	7	6	8	7	8	7
Fly across box	5	3	6	5	1	4

Table I 3 Exp I 2

Behaviour of 8-month old birds housed either in pens or in battery cages, observed undisturbed in the home environment for 2h.
The number of birds of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean ± SE incidences of performance (Mann-Whitney U-Test detected no significant differences).

a. Birds housed in pens

	NO. OF BIRDS		WHITE STOCK		BROWN STOCK	
	WHITE	BROWN	MEAN	SE	MEAN	SE
Number of birds	12	12				
Incidences of:						
Preen	9	8	1.4	0.4	1.4	0.4
Comfort movement	10	11	2.3	0.5	2.6	0.4
Peck environment	5	4	0.7	0.3	0.4	0.2
Defaecate	10	10	1.4	0.3	1.3	0.3

b. Birds housed in battery cages

	NO. OF BIRDS		WHITE STOCK		BROWN STOCK	
	WHITE	BROWN	MEAN	SE	MEAN	SE
Number of birds	10	9				
Incidences of:						
Preen	7	7	2.2	0.7	2.6	0.7
Comfort movement	8	7	2.0	0.5	2.0	0.7
Peck environment	7	7	3.1	1.1	1.1	1.0
Defaecate	9	7	1.7	0.3	0.3	0.1

Table A 1

Exp A 1

The responses shown by 9-month old birds to a stationary human being standing in front of the home cage.

The number of birds of each stock assigned each of the six response scores and the mean ± SE score for each stock.

N = 24 in each stock.

SCORE	1	2	3	4	5	6	MEAN	SE
White stock	13	4	4	3	0	0	1.9	1.1
Brown stock	0	0	2	10	7	5	4.6	0.2

Table A 2

Exp A 2

The responses shown by 9-month old birds to a human being approaching the home cage.

The number of birds of each stock assigned each of the seven response scores and the mean ± SE score for each stock.

N = 24 in each stock.

SCORE	1	2	3	4	5	6	7	MEAN	SE
White stock	4	10	7	2	1	0	0	2.4	0.2
Brown stock	0	0	1	8	4	5	6	5.3	0.3

Table B 1

Exp B 1 & B 2

The responses shown by 16-week old birds and by 10-week old birds to a stationary human being standing in front of the home cage.
The number of birds of each stock-age class assigned each of the six response scores and the mean ± SE score for each class.
N = 16 in each class.

SCORE	1	2	3	4	5	6	MEAN	SE
16-week old:								
White stock	10	1	3	2	0	0	1.8	0.3
Brown stock	0	0	2	8	5	1	4.3	0.2
10-week old:								
White stock	11	2	2	1	0	0	1.6	0.2
Brown stock	0	0	1	9	4	2	4.4	0.2

Table B 2

Exp B 1 & B 2

The responses shown by 16-week old and by 10-week old birds to a human being approaching the home cage.
The number of birds of each stock-age class assigned each of the seven response scores and the mean ± SE score for each class.
N = 16 in each class.

SCORE	1	2	3	4	5	6	7	MEAN	SE
16-week old:									
White stock	15	1	0	0	0	0	0	1.1	0.1
Brown stock	2	1	0	1	11	0	1	4.4	0.4
10-week old:									
White stock	14	1	0	1	0	0	0	1.3	0.2
Brown stock	3	2	0	1	8	0	2	4.1	0.5

Table B 3 (page 1)

The behaviour of 8-month old and of 16-week old birds when a novel object (windmill) was placed in front of the home cage for a period of 300s.

The number of birds in each stock-age class which performed each of the behaviour patterns listed below (χ^2 Test detected no significant stock differences at either age) and the mean $\pm$ SE time (in seconds) or incidences of performance (Mann-Whitney U-test detected no significant stock differences at either age).

N = 9 birds in each stock at 8 months of age and 16 birds in each stock at 16 weeks of age.

AGE	8 MONTHS						16 WEEKS					
	NO. OF BIRDS		WHITE		BROWN		NO. OF BIRDS		WHITE		BROWN	
	WHITE	BROWN	MEAN	SE	MEAN	SE	WHITE	BROWN	MEAN	SE	MEAN	SE
Time spent:												
Fixating windmill	6	4	28.7	7.9	33.0	18.3	7	6	7.9	4.0	13.6	5.6
Pecking windmill	0	1					0	1				
Standing	9	9	300.0	0.0	300.0	0.0	16	15	299.4	0.6	252.6	22.9
Facing cage front	9	9	216.4	22.9	196.1	36.7	16	15	260.5	18.7	190.2	28.4
Facing cage back	7	6	75.9	19.8	62.7	24.4	5	10	22.6	15.9	93.9	28.3
Facing cage side	3	2	7.7	4.2	41.2	27.9	3	5	16.9	9.9	15.9	6.8
Eating	0	1					0	0				
Drinking	7	5	43.8	13.6	36.9	20.7	0	5				
Preening	1	2					1	2				
Dozing	0	0					0	1				
Escape movements	0	0					1	0				

Table B 3 (page 2)

	8 MONTHS						16 WEEKS					
	NO. OF BIRDS		WHITE		BROWN		NO. OF BIRDS		WHITE		BROWN	
	WHITE	BROWN	MEAN	SE	MEAN	SE	WHITE	BROWN	MEAN	SE	MEAN	SE
Incidences of:												
Head out-in at windmill	4	2					10	8	1.6	0.5	2.9	1.4
Peck windmill	3	4					5	4	0.7	0.3	3.0	1.8
Peck-pull windmill	1	2					0	0				
Change direction of facing	5	6	2.2	0.8	1.2	0.4	7	10	0.7	0.3	1.7	0.5
Peck environment	1	1					1	3				
Comfort movement	0	2					3	2				
Yawn	0	0					0	2				
Defaecate	0	0					4	2				
Preen	0	0					2	3				
Soft call	0	1					0	3				

Table B 4

Exp B 4

The responses shown by 9-month old and by 16-week old birds to a novel stimulus (balloon) approaching within the home cage.
The number of birds of each stock-age class assigned each of the seven response scores and the mean ± SE score for each class.
N = 18 birds of each stock at 9 months of age and 16 of each stock at 16 weeks of age.

SCORE	1	2	3	4	5	6	7	MEAN	SE
9-month old:									
White stock	13	5	0	0	0	0	0	1.2	0.1
Brown stock	2	6	0	2	6	1	1	3.6	0.4
16-week old:									
White stock	15	1	0	0	0	0	0	1.0	0.1
Brown stock	11	4	0	1	0	0	0	1.4	0.2

Table B 5

Exp B 5

The responses shown by 4-day old and by 1-day old chicks to a novel stimulus (hand) approaching within the home box.
The number of chicks of each stock-age class assigned each of six response scores and the mean ± SE score for each class.
N = 30 in each class.

SCORE	1	2	3	4	5	6	MEAN	SE
4-day old:								
White stock	5	10	4	11	0	0	2.7	0.2
Brown stock	1	8	4	11	1	5	3.6	0.3
1-day old:								
White stock	0	6	11	9	1	3	3.5	0.2
Brown stock	0	3	4	12	4	7	4.3	0.2

Table C 2 Exp C 1

The behaviour of 9-month old birds isolated in a cage in a sound-proof room for 900s.

The number of birds of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean ± SE times (in seconds) or incidences of performance (Mann-Whitney U-Test detected no significant differences).

N = 14 in each stock.

	NO. OF BIRDS		FLIGHTY STK.		DOCILE STK.	
	FLTY.	DCL.	MEAN	SE	MEAN	SE
Time spent:						
Standing	12	11	433.9	73.1	399.2	80.0
Lying	13	13	466.1	73.1	500.8	80.0
Eyes closed	7	5	21.8	14.7	4.7	2.8
Preening	3	6	20.1	12.1	57.2	22.9
Clucking	4	1				
Alarm calling	3	0				
Incidences of:						
Change stance	11	10	3.4	1.1	5.8	3.1
Preen	12	11	3.0	0.6	3.9	0.8
Peck environment	8	10	2.6	0.9	3.4	1.0
Comfort movement	7	9	2.0	1.1	3.1	1.2
Yawn	7	6	5.6	1.9	2.0	1.0
Defaecation	3	3				
Single step	12	11	47.3	13.8	34.5	8.9
Nibble	3	6				
Soft call	5	5	3.9	2.3	4.9	2.3
Cluck	3	2				

Table C 3 Exp C 2

The behaviour of 14-week old birds isolated in a cage in a sound-proof room for 900s.
The number of birds of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean $\pm$ SE times (in seconds) or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.
N = 10 in each stock.

	NO. OF BIRDS		FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	MEAN	SE	MEAN	SE	
Time spent:							
Standing	8	10	411.3	106.4	678.1	83.1	
Lying	8	6	488.7	106.4	221.9	83.1	
Eyes closed	3	3					
Preening	4	2					
Escape movement	2	3					
Clucking	1	4					
Incidences of:							
Change stance	7	6	1.4	0.4	0.7	0.2	
Preen	6	8	2.0	0.6	1.5	0.4	
Peck environment	7	8	5.1	2.8	4.7	1.3	
Comfort movement	3	6					
Yawn	1	1					
Defaecation	4	9	1.7	0.7	2.4	0.5	0.02
Single step	7	10	20.6	7.5	56.1	21.5	
Nibble	6	9	1.9	0.7	4.1	1.0	
Soft call	5	10	8.3	3.7	14.2	3.0	

Table C 4 Exp C 3

The behaviour of 10-week old birds isolated in a cage in a sound-proof room for 900s.

The number of birds of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean $\pm$ SE times (in seconds) or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.

N = 12 in each stock.

	NO. OF BIRDS		FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	MEAN	SE	MEAN	SE	
Time spent:							
Standing	10	8	497.7	96.9	503.7	101.2	
Lying	9	12	402.3	96.9	396.3	101.2	
Eyes closed	0	4					
Preening	2	2					
Escape movement	5	3					
Vocalizing	1	3					
Incidences of:							
Change stance	7	8	1.3	0.4	0.7	0.2	
Preen	7	3	1.1	0.3			
Peck environment	9	8	7.4	2.1	4.1	1.8	
Comfort movement	2	3					
Yawn	0	0					
Defaecation	6	5	0.9	0.3	1.1	0.5	
Single step	8	7	40.5	14.7	32.6	19.1	
Nibble	6	5	0.5	0.2	7.1	5.6	
Jump at wall	2	2					
Soft call	10	8	12.3	3.5	4.3	1.1	0.02

Table C 5 Exp C 4

The behaviour of 6-week old birds isolated in a cage in a sound-proof room for 900s.

The number of birds of each stock which performed each of the behaviour patterns listed below, with statistical analysis by the χ^2 Test; and the mean $\pm$ SE times (in seconds) or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.

N = 15 in each stock.

	NO. OF BIRDS			FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	p <	MEAN	SE	MEAN	SE	
Time spent:								
Standing	13	13		566.3	85.8	652.5	71.7	
Lying	13	15		333.7	85.8	247.5	71.7	
Eyes closed	1	1						
Preening	0	2						
Escape mvt.	3	3						
Beak on ground	0	1						
Peeping	9	13		348.8	100.8	476.6	74.5	
Incidences of:								
Change stance	12	13		1.1	0.2	1.8	0.5	
Preen	6	3						
Peck envirn.	3	9				1.9	0.7	0.05
Comfort mvt.	8	13		0.8	0.3	1.5	0.4	
Yawn	0	2						
Defaecation	13	14		1.6	0.3	2.1	0.3	
Single step	12	12		64.6	15.4	140.0	41.4	
Nibble	4	4						
Jump at wall	2	0						
Fly across cage	10	3	0.02	1.9	0.5			
Peep	11	13		9.1	3.5	5.5	2.2	

Table C 6

Exp C 5

The behaviour of chicks isolated in a cage in a sound-proof room for 900s.

The number of chicks in each stock-rearing-age class which performed each of the behaviour patterns listed below, with statistical analysis by the χ^2 Test using Cochran's (1954) modification.

N = 14 in each class.

STOCK	FLIGHTY						DOCILE						EFFECTS OF:-		
REARING	GROUP			ISOLATE			GROUP			ISOLATE			STOCK	REARING	AGE
AGE IN DAYS	4	7	14	4	7	14	4	7	14	4	7	14	p <	p <	p <
Standing	11	7	6	11	9	9	12	11	8	13	11	8			0.002
"Sitting"	9	0	5	4	3	5	9	11	4	5	2	4		0.05	0.02
Lying	10	14	14	8	10	11	8	9	11	8	7	14		0.02	0.002
Change stance	13	7	9	7	6	9	10	12	9	9	6	8			
Eyes closed	11	13	14	10	10	7	12	13	12	9	5	10		0.002	
Beak on ground	5	9	13	8	10	7	6	6	9	4	2	7	0.02		0.05
Walk	8	1	3	9	4	4	6	6	5	11	9	6	0.002	0.02	0.002
Preen	0	0	0	0	1	0	0	0	0	1	1	1			
Peep	10	4	3	13	9	7	14	14	11	14	13	8	0.002		0.002
Peck environment	0	0	0	1	2	0	0	0	0	1	3	2			
Jump at walls	5	0	1	3	0	3	3	3	2	0	3	0			
Defaecate	0	1	1	2	1	0	1	2	1	0	0	1			

Table C 7 Exp C 5

Behaviour of chicks isolated in a cage in a sound-proof room for 900s. Results of the analysis of variance of the main effects (age, stock and rearing) and their interactions, on the times or incidences of performance of the behaviour patterns listed below. If the actual numbers of chicks performing any behaviour pattern were significantly different no analysis of times or incidences was carried out and the letter N has been entered in the table below.

SOURCE OF VARIATION	AGE	STOCK	REARING	A x S	A x R	S x R	A x S x R
DEGREES OF FREEDOM	2	1	1	2	2	1	2
	VARIANCE RATIOS						
Time spent:							
Standing	N	10.07 **	4.50 *	0.35	0.79	0.73	0.33
"Sitting"	N	0.33	N	8.55 ***	3.67 *	0.03	4.42 *
Lying	N	8.96 **	N	1.89	0.66	0.66	1.06
Eyes closed	1.34	8.19 **	N	3.07 *	2.51	0.48	2.41
Beak on ground	N	N	7.51 **	3.22 *	1.28	0.10	2.62
Peeping	N	N	0.91	5.07 **	0.23	4.43 *	2.07
Incidences of:							
Change stance	0.58	3.64	0.21	0.65	3.19 *	0.27	3.00 *
Single step	N	N	N	0.47	0.61	0.43	0.36

Residual degrees of freedom = 156

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

Table C 8 (page 1)

The behaviour of chicks isolated in a cage in a sound-proof room for 900s.

The mean ± SE time (in seconds) or incidences of performance of each of the behaviour patterns listed below, by chicks in each stock-rearing-age class.

N = 14 in each class.

4 - day old chicks

STOCK	FLIGHTY				DOCILE			
REARING	GROUP		ISOLATE		GROUP		ISOLATE	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Time spent:								
Standing	370.2	87.8	472.9	103.1	537.0	85.1	640.9	85.8
"Sitting"	192.7	65.7	34.1	17.4	56.4	16.3	27.4	13.6
Lying	337.1	85.6	393.0	105.3	306.6	87.9	231.7	84.6
Eyes closed	193.1	69.6	271.8	77.3	206.8	61.7	79.7	26.9
Beak on ground	160.9	70.8	201.7	69.6	149.6	60.5	29.6	17.1
Peeping	309.4	62.3	342.1	81.8	464.5	70.1	514.1	76.3
Incidences of:								
Change stance	1.8	0.3	1.1	0.9	1.7	0.4	1.5	0.4
Single step	2.3	0.7	3.6	2.6	3.8	2.8	3.6	1.0

Table C 8 (page 2)

7-day old chicks

STOCK	FLIGHTY				DOCILE			
REARING	GROUP		ISOLATE		GROUP		ISOLATE	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Time spent:								
Standing	171.6	68.8	396.8	108.1	423.6	98.1	582.6	106.7
"Sitting"	0.0	0.0	8.9	4.9	131.9	38.9	40.7	29.6
Lying	728.4	68.8	494.3	109.6	344.5	91.5	276.7	92.8
Eyes closed	438.5	65.7	232.4	66.8	169.2	48.4	49.1	28.3
Beak on ground	407.8	100.7	238.9	63.4	114.1	52.3	27.5	23.9
Peeping	72.0	41.8	223.4	66.2	474.8	58.8	490.4	72.8
Incidences of:								
Change stance	0.5	0.1	0.9	0.3	2.4	0.7	0.9	0.3
Single step	1.0	1.0	2.6	1.5	3.5	1.2	5.9	1.8

Table C 8 (page 3)

14-day old chicks

	FLIGHTY				DOCILE			
	GROUP		ISOLATE		GROUP		ISOLATE	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Time spent:								
Standing	125.3	55.6	263.2	91.2	341.4	104.6	273.9	83.5
"Sitting"	44.3	21.7	61.9	29.9	12.4	5.6	18.3	15.1
Lying	730.4	66.9	574.9	101.1	546.2	105.2	607.8	89.1
Eyes closed	418.1	59.2	147.8	55.6	286.7	66.4	242.4	79.1
Beak on ground	500.1	64.6	201.9	72.6	316.4	74.7	257.4	81.8
Peeping	78.3	47.1	278.4	95.1	308.1	87.0	122.8	57.5
Incidences of:								
Change stance	1.00	0.3	1.2	0.4	0.8	0.3	3.8	1.7
Single step	1.8	1.0	2.8	1.6	5.0	2.4	3.4	1.2

Table C 9

Exp C 6

The behaviour of 9-month old birds isolated in a cardboard box, before emerging into a strange pen.
The number of birds of each stock which performed each of the behaviour patterns listed below, with statistical analysis by the χ^2 Test; and the mean $\pm$ SE % times, or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.
N = 15 in each stock.

	NO. OF BIRDS			FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	p <	MEAN	SE	MEAN	SE	
Total time in box (s)	15	15		449.0	109.4	2245.1	578.9	0.002
% Time spent:								
Lying	13	15		65.6	10.4	76.9	5.8	
Facing front	13	14		59.9	10.9	65.1	9.4	
Facing side	7	9		14.3	7.5	8.3	2.4	
Facing back	8	8		25.8	9.4	26.6	8.8	
Head outside	6	13	0.02	4.1	2.2	12.7	3.7	
Incidences of:								
Change stance	10	14		1.1	0.3	5.3	1.2	0.002
Change direction	9	10		1.3	0.5	2.6	0.7	
Head in-out of box	6	13	0.02	3.0	2.0	6.2	1.2	
Peck box	4	12	0.02	0.8	0.5	9.4	3.5	
Peck litter	2	7	0.05					
Pant	0	3						
Preen	0	2						
Comfort movement	1	1						
Yawn	0	2						
Soft call	1	8	0.02					

Table C 10 Exp C 7

The behaviour of 14-week old birds isolated in a cardboard box, before emerging into a strange pen.

The number of birds of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean ± SE % times, or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.

N = 12 in each stock.

	NO. OF BIRDS		FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	MEAN	SE	MEAN	SE	
Total time in box (s)	12	12	893.2	412.7	3513.8	1161.1	0.05
% Time spent:							
Lying	12	12	89.6	6.5	88.7	6.6	
Facing front	10	11	77.2	11.8	72.9	11.0	
Facing side	3	7	15.9	10.8	16.5	8.8	
Facing back	3	3	6.9	5.8	10.6	7.4	
Head outside	6	9	3.5	1.9	19.8	9.1	
Incidences of:							
Change stance	8	11	1.5	0.5	3.7	1.3	
Change direction	3	7	0.9	0.5	1.7	0.6	
Head in-out of box	7	9	1.7	0.5	6.9	3.4	
Peck box	4	7					
Peck litter	5	5					
Pant	0	0					
Preen	1	2					
Comfort movement	0	0					
Yawn	0	1					
Soft call	0	0					

Table C 11 Exp C 6

The behaviour of 9-month old birds isolated in a strange pen for 900s.

The number of birds of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean $\pm$ SE times (in seconds) or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.

N = 15 in each stock.

	NO. OF BIRDS		FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	MEAN	SE	MEAN	SE	
Latency to walk	15	15	26.4	14.6	141.1	59.6	0.02
Total steps	15	14	111.4	13.9	48.5	9.1	0.002
Total squares	15	15	12.3	1.7	5.5	1.1	0.02
Variety squares	15	15	6.6	0.4	4.2	0.5	0.02
Time spent:							
Pecking litter	11	7	308.1	64.9	138.1	49.5	
Preening	1	1					
Panting	3	6					
Clucking	5	6					
Alarm calling	0	3					
Incidences of:							
Run across pen	7	3					
Fly across pen	8	8	1.2	0.3	0.9	0.2	
Jump at wall	0	1					
Peck litter	13	13	6.3	1.0	4.2	1.0	
Peck environment	4	9					
Preen	10	8	2.3	0.7	1.5	0.5	
Wing flap	13	12	5.1	1.2	3.8	0.9	
Comfort movement	11	8	2.8	0.8	2.4	1.1	
Yawn	5	5					
Defaecation	10	10	0.7	0.1	0.7	0.1	
Soft call	8	6					
Latency to defaecate	10	10	418.4	76.0	435.5	84.7	

Table C 12 Exp C 7

The behaviour of 14-week old birds isolated in a strange pen for 900s. The number of birds of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean $\pm$ SE times (in seconds) or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.

N = 12 in each stock.

	NO. OF BIRDS		FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	MEAN	SE	MEAN	SE	
Latency to walk	12	12	79.9	27.6	58.9	31.2	
Total steps	12	12	131.5	39.0	70.2	13.0	
Total squares	12	12	21.9	8.2	6.3	1.1	
Variety squares	12	12	5.9	0.6	3.8	0.5	0.05
Time spent:							
Pecking litter	9	7	137.5	49.3	95.6	44.2	
Preening	3	5					
Panting	3	0					
Clucking	3	1					
Alarm calling	0	0					
Incidences of:							
Run across pen	4	3					
Fly across pen	8	10	1.5	0.4	1.2	0.2	
Jump at wall	2	2					
Peck litter	8	8	4.2	1.3	3.3	0.9	
Peck environment	1	4					
Preen	6	7	0.8	0.2	2.1	0.6	
Wing flap	7	7	1.5	0.5	0.9	0.3	
Comfort movement	5	0					
Yawn	0	0					
Defaecation	7	10	0.6	0.2	0.8	0.3	
Soft call	5	2					
Latency to defaecate	7	10	316.7	67.8	154.2	72.4	

Table C 13 Exp C 8

Behaviour of chicks, reared in pairs, left alone in the home box after the removal of their companion.

The number of chicks in each stock-age class which, during a 300s observation, performed each of the behaviour patterns listed below. There were no statistically significant differences due either to stock or age, (χ^2 Test with Cochran's (1954) modification).

N = 12 in each class.

STOCK	FLIGHTY			DOCILE		
AGE IN DAYS	4	7	14	4	7	14
Time spent:						
Standing	12	12	12	12	12	12
Eyes closed	5	5	7	8	7	6
Beak on ground	0	3	3	2	6	3
On jar	7	2	2	3	7	2
Eating	2	1	0	3	2	3
Drinking	0	0	1	0	0	0
Preening	1	1	1	2	0	1
Pecking litter	4	1	1	1	1	1
Pacing	2	1	0	0	0	0
Peeping	9	5	3	8	7	5
Incidences of:						
Peck environment	2	2	1	2	2	2
Walk across box	10	9	8	10	7	9
Defaecation	6	5	4	2	6	3
Jump at wall	2	3	0	2	5	2
Comfort movement	2	3	2	0	5	3
On/off jar	3	3	1	3	2	2

Table C 14 Exp C 8

The behaviour of chicks when left alone in the home environment for 300s after the removal of their companion.

The mean $\pm$ SE time (in seconds) or incidences of performance of each of the behaviour patterns listed below, by chicks of each stock-age class.

N = 12 in each class.

STOCK		FLIGHTY			DOCILE		
AGE IN DAYS		4	7	14	4	7	14
Time spent:							
Standing	$\bar{x}$	283.3	264.7	210.3	280.0	193.4	246.5
	SE	10.4	44.2	55.2	13.7	29.5	23.8
Eyes closed	$\bar{x}$	46.3	44.2	55.3	75.2	73.3	38.8
	SE	20.7	20.8	20.9	23.8	21.4	17.0
Beak on ground	$\bar{x}$	0.0	14.5	24.9	13.6	56.6	23.4
	SE	0.0	10.2	14.2	10.7	20.5	13.2
On top of jar	$\bar{x}$	37.7	32.4	24.3	20.9	45.2	18.9
	SE	16.5	21.9	16.5	11.9	24.9	12.6
Peeping	$\bar{x}$	106.5	27.7	20.5	80.3	90.1	48.0
	SE	32.3	16.2	13.1	25.6	28.0	20.8
Incidences of:							
Walking across the box	$\bar{x}$	2.9	2.4	1.7	3.6	3.7	2.3
	SE	1.1	0.9	0.7	1.0	1.2	0.7

Table C 15 Exp C 10

The behaviour of 14-week old birds during their first 30 min. in individual battery cages after transferral from a communal rearing cage.

The number of birds of each stock which performed each of the behaviour patterns listed below, with statistical analysis by the χ^2 Test; and the mean $\pm$ SE times (in seconds) or incidences of performance (Mann-Whitney U-Test detected no significant differences).

N = 16 in each stock.

	NO. OF BIRDS			FLIGHTY STK.		DOCILE STK.	
	FLTY.	DCL.	p $\angle$	MEAN	SE	MEAN	SE
Time spent:							
Standing	16	16		1383.1	162.8	1429.1	99.7
Facing front	15	15		966.4	122.6	942.6	140.5
Facing back	15	16		644.3	131.8	332.4	74.7
Facing neighbour	11	16		189.3	53.3	524.9	139.6
Head out at front	8	9		70.8	32.3	55.8	19.4
Head out at back	1	1					
Escape movement	7	6		46.4	20.6	97.9	50.1
Eating	8	14		168.4	49.4	202.1	68.9
Drinking	2	2					
Preening	10	6		59.3	22.3	68.4	50.3
Peck environment	3	1					
Dozing	3	3					
Panting	1	3					
Incidences of:							
Change stance	16	16		2.3	0.4	2.1	0.3
Change direction	15	16		7.4	1.4	8.4	1.2
Head in-out	9	2					
Eat	14	5	0.01	1.8	0.3	0.4	0.2
Drink	3	0					
Preen	11	5					
Peck environment	13	13		7.4	1.9	4.0	1.1
Defaecation	0	1					
Comfort movement	0	1					
Yawn	2	1					

Table C 16 Exp C 11

The behaviour of 5-month old birds when several novel objects are placed in the "home" pen for a 2h. period.
The number of birds of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean $\pm$ SE times (in seconds) or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.
N = 12 in each stock.

	NO. OF BIRDS		FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	MEAN	SE	MEAN	SE	
Time spent:							
Lying	12	10	2908.6	726.1	2370.3	609.4	
Dozing	9	7	920.7	272.6	475.6	309.2	
Head under wing	3	3					
Eating	10	10	518.9	196.9	926.3	322.1	
Drinking	9	10	140.2	38.2	225.0	62.3	
Pecking litter	12	12	1840.0	343.6	2215.6	370.6	
Preening	12	12	1174.2	160.6	1762.5	318.5	
Fixating objects	11	8	151.7	47.2	14.5	6.1	0.002
Pecking objects	10	9	1285.9	394.9	310.4	108.8	
Incidences of:							
Comfort movement	12	12	19.2	3.1	17.0	3.8	
Yawn	10	9	6.7	3.4	8.3	2.2	
Defaecation	11	7	2.1	0.6	1.3	0.4	
Soft call	2	5					
Look at objects	11	9	4.3	1.0	1.9	0.5	
Fixate objects	12	10	15.7	2.5	6.3	1.8	0.02
Peck objects	11	11	10.8	1.5	7.8	1.9	
Total squares	12	12	80.7	16.2	64.0	14.9	
Variety squares	12	12	7.3	0.7	6.9	0.5	

Table C 17 Exp C 12

The behaviour of 9-month old birds when (a) the normal, and (b) a novel food is given for a 300s period between deprivations. The number of birds of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean $\pm$ SE times (in seconds) or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.

N = 19 in each stock.

	NO. OF BIRDS		FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	MEAN	SE	MEAN	SE	
NORMAL FOOD							
Latency to head out	19	19	10.0	5.0	3.1	1.4	
Latency to 1st peck	19	19	13.0	6.1	5.8	1.9	
Pecking bouts	19	19	5.3	0.8	3.6	0.5	
Total pecks	19	19	195.9	22.3	259.1	26.3	0.05
Time spent:							
Facing front	19	19	282.4	10.1	299.8	0.2	
Head in cage	18	17	88.9	18.1	58.7	15.0	
Pecking food	19	19	206.1	18.4	231.6	16.7	
Drinking	2	0					
Preening	0	2					
NOVEL FOOD							
Latency to head out	19	18	3.7	2.1	15.9	15.8	
Latency to 1st peck	19	16	14.8	3.5	73.7	25.5	
Pecking bouts	19	16	6.8	0.9	4.7	1.1	
Total pecks	19	16	174.9	26.0	220.5	41.8	
Time spent:							
Facing front	19	19	290.2	4.7	286.1	9.4	
Head in cage	18	18	95.9	17.1	111.4	25.2	
Pecking food	19	16	189.7	18.4	169.4	26.3	
Drinking	1	0					
Preening	0	0					

Table C 18 Exp C 13

The responses of 14-week old birds on their first exposure to the mechanical scraper in the battery unit.

The number of birds in each stock which responded in each of the nine different ways observed, when the scraper passed with blade up and then with blade down.

N = 16 in each stock.

RESPONSE	SCORE	BLADE UP		BLADE DOWN	
		FLIGHTY STOCK	DOCILE STOCK	FLIGHTY STOCK	DOCILE STOCK
Panic	9	8	6	5	12
Jumping at walls	8	4	3	2	0
Single jump	7	0	3	4	3
Clawing at walls	6	0	1	0	0
Escape movements	5	0	0	1	0
Lifts one foot	4	0	0	0	1
Steps on spot	3	0	0	1	0
Stands still	2	1	0	2	0
Looks at scraper	1	3	3	1	0
Score $\bar{x}$		6.8	6.7	6.4	8.3
SE		0.8	0.7	0.7	0.4

Table C 19 Exp C 15

The initial responses of chicks, reared in visual isolation, to a novel object placed in the home environment.

The number of chicks in each stock-age class which responded in each of the three ways listed below.

Statistical analysis by the χ^2 Test using Cochran's (1954) modification.

N = 12 in each class.

STOCK	FLIGHTY			DOCILE			p <	
AGE IN DAYS	4	7	14	4	7	14	STOCK	AGE
Response:								
Panic	3	2	6	1	3	5		0.01
Fixate directly	4	1	0	7	7	3	0.001	0.01
Fixate sideways	5	9	6	4	2	4	0.01	

Table C 20 Exp C 15

Behaviour of chicks, reared in visual isolation, when a novel object was placed in the home environment.
The number of chicks in each stock-age class which, during a 300s observation, performed each of the behaviour patterns listed below.
There were no statistically significant differences due either to stock or age, (χ^2 Test using Cochran's (1954) modification).
N = 12 in each class.

STOCK	FLIGHTY			DOCILE		
AGE IN DAYS	4	7	14	4	7	14
Time spent:						
Fixating directly	7	7	5	10	7	8
Fixating sideways	11	12	12	12	12	12
Facing wall	12	10	10	11	11	12
Panicking	4	3	7	2	4	5
Pacing at wall	9	10	9	7	9	9
Walking about	1	5	3	3	1	2
Eating	2	1	2	0	1	1
Drinking	2	0	0	2	0	1
Preening	3	2	1	1	1	0
Pecking litter	0	1	1	0	0	0
Pecking envirn.	1	2	1	1	4	1
Eyes closed	1	3	0	1	1	2
Peeping	4	5	3	5	3	3

Table C 21 Exp C 15

Behaviour of chicks, reared in visual isolation, when a novel object was placed in the home environment.
The number of chicks in each stock-age class which, during a 300s observation, performed each of the behaviour patterns listed below.
Statistical analysis by the χ^2 Test using Cochran's (1954) modification.
N = 12 in each class.

STOCK	FLIGHTY			DOCILE			p <	
AGE IN DAYS	4	7	14	4	7	14	STOCK	AGE
Incidences of:								
Approach	5	1	1	4	1	1		0.05
Retreat	4	2	1	7	2	3	0.02	0.05
Peck object	3	0	1	2	0	0		
Run/fly box	6	4	2	2	4	1		
Jump at wall	10	8	3	5	8	5		0.02
Jump on jar	3	5	5	4	5	10		0.02
Eat	0	0	1	0	0	1		
Drink	3	3	0	2	3	4		
Preen	3	3	4	4	3	2		
Peck environment	4	6	7	2	6	4		
Comfort movement	4	2	2	3	2	0		
Yawn	0	0	0	0	0	1		
Defaecation	5	4	3	1	4	2		
Fear trill	4	3	1	4	3	3		
Peep	5	1	3	5	1	2		

Table C 22 Exp C 18

The behaviour of 7-day old chicks when the normal food is given for a 300s period between deprivations.

The number of chicks of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean $\pm$ SE times (in seconds) or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.

N = 20 in each stock.

	NO. OF BIRDS		FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	MEAN	SE	MEAN	SE	
Latency to "in dish"	20	20	48.5	20.3	39.2	20.6	
Latency to eat	20	20	57.4	19.7	41.4	20.4	0.05
Time spent:							
"At food dish"	19	18	248.0	21.5	262.2	20.7	
"In food dish"	18	18	198.4	24.0	210.2	23.8	
Eating	18	18	206.4	22.5	233.5	22.9	
"At water jar"	5	2					
Drinking	0	2					
"At front of box"	7	4					
Standing	20	18	298.3	1.6	270.0	20.7	
Eyes closed	2	2					
Beak on ground	0	2					
Pecking litter	2	3					
Preening	4	1					
Incidences of:							
Preen	1	1					
Comfort movement	0	1					
Peck environment	0	1					
Peep	0	0					

Table C 23 Exp C 18

The behaviour of 8-day old chicks when a novel food is given for a 300s period between deprivations.
The number of chicks of each stock which performed each of the behaviour patterns listed below (χ^2 Test detected no significant differences); and the mean $\pm$ SE times (in seconds) or incidences of performance with statistical analysis by the Mann-Whitney U-Test, 2-tailed.
N = 20 in each stock.

	NO. OF BIRDS		FLIGHTY STK.		DOCILE STK.		p <
	FLTY.	DCL.	MEAN	SE	MEAN	SE	
Latency to "in dish"	20	20	116.3	31.4	196.9	32.3	
Latency to eat	20	20	221.8	27.9	285.3	14.7	
Time spent:							
"At food dish"	15	9	94.4	25.7	19.6	7.6	0.02
"In food dish"	13	6	60.6	19.8	2.3	1.6	0.02
Eating	6	1					
"At water jar"	10	13	46.0	17.7	26.8	10.1	
Drinking	1	2					
"At front of box"	14	20	152.3	27.3	253.1	12.7	
Standing	20	20	300.0	0.0	286.9	7.9	
Eyes closed	4	5					
Beak on ground	1	4					
Pecking litter	3	8					
Preening	1	6					
Incidences of:							
Preen	1	2					
Comfort movement	0	3					
Peck environment	4	1					
Peep	2	2					

Table D 2

Exp D 1

The responses of 7-month old birds when being removed by the Experimenter from (a) the home battery cage and (b) the experimental cage, on each of 6 consecutive days.

Stage 1. Experimenter stands in front of cage.

The number of birds in each stock-treatment class assigned each of the ten possible response scores over the total 6 days.

N = 10 birds in each class except the docile-stock deprived in which N = 9.

a. Removal from home battery cage

CLASS	RESPONSE SCORE									
	1	2	3	4	5	6	7	8	9	10
Flighty stock, non-hungry	0	0	8	9	8	31	4	0	0	0
Docile stock, non-hungry	11	3	34	2	2	8	0	0	0	0
Flighty stock, deprived	0	0	16	9	8	19	6	2	0	0
Docile stock, deprived	18	2	31	1	0	2	0	0	0	0

b. Removal from experimental cage

CLASS	RESPONSE SCORE									
	1	2	3	4	5	6	7	8	9	10
Flighty stock, non-hungry	0	1	18	18	14	3	0	1	5	0
Docile stock, non-hungry	0	0	22	17	16	2	0	0	3	0
Flighty stock, deprived	0	4	26	11	8	8	0	0	1	2
Docile stock, deprived	0	1	35	5	11	0	0	0	2	0

Table D 3

The responses of 7-month old birds when being removed by the Experimenter from (a) the home battery cage and (b) the experimental cage, on each of 6 consecutive days.

Stage 1. Experimenter stands in front of cage.

The daily mean ± SE response scores obtained by birds in each stock-treatment class.

N = 10 birds in each class except the docile stock deprived in which N = 9.

CLASS	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6	
	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Removal from home battery cage												
Flighty stock, non-hungry	4.9	0.5	5.6	0.3	5.7	0.2	4.9	0.5	5.1	0.3	5.2	0.4
Docile stock, non-hungry	3.1	0.4	3.0	0.6	2.4	0.3	3.5	0.4	3.4	0.6	3.1	0.5
Flighty stock, deprived	5.0	0.4	5.4	0.5	5.0	0.6	4.8	0.5	4.6	0.5	4.8	0.5
Docile stock, deprived	2.6	0.3	3.0	0.5	2.4	0.3	2.4	0.6	2.1	0.4	2.0	0.3
Removal from experimental cage												
Flighty stock, non-hungry	6.5	0.7	5.4	0.6	3.9	0.2	3.6	0.3	3.9	0.3	3.6	0.2
Docile stock, non-hungry	4.5	0.6	4.5	0.6	4.5	0.6	3.8	0.3	3.8	0.3	4.2	0.3
Flighty stock, deprived	5.9	0.7	5.0	0.6	3.4	0.3	3.3	0.4	3.2	0.3	3.9	0.4
Docile stock, deprived	5.0	0.8	3.8	0.3	3.7	0.3	3.3	0.2	3.0	0.2	3.4	0.3

Table D4 Exp D 1

The responses of 7-month old birds when being removed by the Experimenter from (a) the home battery cage and (b) the experimental cage, on each of 6 consecutive days.

Stage 2. Experimenter places hands on cage.

The number of birds in each stock-treatment class assigned each of the eleven possible response scores over the total 6 days.

N = 10 birds in each class except the docile stock deprived in which N = 9.

a. Removal from home battery cage

CLASS	RESPONSE SCORE										
	1	2	3	4	5	6	7	8	9	10	11
Flighty stock, non-hungry	0	0	0	0	1	8	21	23	6	1	0
Docile stock, non-hungry	1	1	0	22	18	6	9	3	0	0	0
Flighty stock, deprived	0	0	0	2	3	7	15	22	7	0	4
Docile stock, deprived	7	2	1	20	20	1	3	0	0	0	0

b. Removal from experiment cage

CLASS	RESPONSE SCORE										
	1	2	3	4	5	6	7	8	9	10	11
Flighty stock, non-hungry	0	0	3	16	14	16	7	2	1	1	0
Docile stock, non-hungry	1	0	3	23	14	16	3	0	0	0	0
Flighty stock, deprived	0	0	4	22	12	8	9	0	1	2	2
Docile stock, deprived	3	0	0	34	5	10	2	0	0	0	0

Table D 5

Exp D 1

The responses of 7-month old birds when being removed by the Experimenter from (a) the home battery cage and (b) the experimental cage, on each of 6 consecutive days.

Stage 2. Experimenter places hands on cage.

The daily mean $\pm$ SE response scores obtained by birds in each stock-treatment class.

N = 10 birds in each class except the docile stock deprived in which N = 9.

CLASS	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Removal from home battery cage												
Flighty stock, non-hungry	7.3	0.3	7.4	0.3	7.2	0.8	7.7	0.3	7.5	0.3	7.0	0.3
Docile stock, non-hungry	4.7	0.5	5.1	0.4	5.3	0.5	5.0	0.5	5.2	0.4	5.1	0.4
Flighty stock, deprived	7.2	0.4	8.3	0.5	8.0	0.5	7.7	0.5	7.7	0.5	7.1	0.5
Docile stock, deprived	4.3	0.7	4.9	0.3	3.8	0.5	3.8	0.6	4.2	0.4	3.6	0.4
Removal from experimental cage												
Flighty stock, non-hungry	6.7	0.3	6.1	0.6	5.3	0.5	4.5	0.3	5.0	0.3	4.7	0.4
Docile stock, non-hungry	5.1	0.4	4.8	0.3	4.5	0.5	4.7	0.3	4.7	0.4	5.1	0.4
Flighty stock, deprived	6.5	0.6	6.5	0.9	4.1	0.5	4.7	0.4	5.1	0.6	4.9	0.4
Docile stock, deprived	5.3	0.4	4.8	0.3	4.3	0.5	4.3	0.2	3.4	0.5	4.2	0.2

Table D 6

Exp D 1

The responses of 7-month old birds when being removed by the experimenter from (a) the home battery cage and (b) the experimental cage, on each of 6 consecutive days.

Stage 3. Experimenter opens the cage.

The number of birds in each stock-treatment class assigned each of the ten possible response scores over the total 6 days.

N = 10 birds in each class except the docile stock deprived in which N = 9.

a. Removal from home battery cage

CLASS	RESPONSE SCORE									
	1	2	3	4	5	6	7	8	9	10
Flighty stock, non-hungry	0	0	0	0	12	9	29	6	3	1
Docile stock, non-hungry	3	2	17	21	6	9	2	0	0	0
Flighty stock, deprived	0	0	1	5	7	16	20	0	1	1
Docile stock, deprived	4	9	17	21	1	2	0	0	0	0

b. Removal from experimental cage

CLASS	RESPONSE SCORE									
	1	2	3	4	5	6	7	8	9	10
Flighty stock, non-hungry	0	0	15	19	9	6	0	0	11	0
Docile stock, non-hungry	0	0	22	18	17	2	0	0	1	0
Flighty stock, deprived	0	0	20	10	6	8	0	0	16	0
Docile stock, deprived	5	0	31	6	10	1	0	0	1	0

Table D 7

The responses of 7-month old birds when being removed by the Experimenter from (a) the home battery cage and (b) the experimental cage, on each of 6 consecutive days.

Stage 3. Experimenter opens the cage.

The daily mean $\pm$ SE response scores obtained by birds in each stock-treatment class

N = 10 birds in each class except the docile stock deprived in which N = 9.

CLASS	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Removal from home battery cage												
Flighty stock, non-hungry	7.0	0.3	7.0	0.5	6.9	0.3	6.5	0.3	6.5	0.5	6.3	0.3
Docile stock, non-hungry	4.1	0.4	3.9	0.5	4.0	0.5	3.8	0.4	4.2	0.4	4.0	0.5
Flighty stock, deprived	6.5	0.4	7.4	0.4	6.7	0.3	5.8	0.4	6.4	0.3	5.7	0.5
Docile stock, deprived	3.6	0.2	4.0	0.3	3.2	0.2	2.8	0.5	2.8	0.4	3.0	0.3
Removal from experimental cage												
Flighty stock, non-hungry	5.2	0.3	5.1	0.7	5.0	0.7	4.7	0.7	4.7	0.7	5.4	0.8
Docile stock, non-hungry	4.2	0.3	4.0	0.3	4.6	0.6	3.8	0.3	3.8	0.3	4.1	0.3
Flighty stock, deprived	6.4	0.6	5.3	0.9	4.8	0.8	5.1	0.7	5.5	0.8	5.1	0.9
Docile stock, deprived	4.6	0.7	3.8	0.3	3.7	0.5	2.9	0.4	2.7	0.3	3.2	0.2

Table D 8 Exp D 1

The responses of 7-month old birds when being removed by the Experimenter from (a) the home battery cage and (b) the experimental cage, on each of 6 consecutive days.

Stage 4. Experimenter reaches for bird.

The number of birds in each stock-treatment class assigned each of the nine possible response scores over the total 6 days.

N = 10 birds in each class except the docile stock deprived in which N = 9.

a. Removal from home battery cage

CLASS	RESPONSE SCORE								
	1	2	3	4	5	6	7	8	9
Flighty stock, non-hungry	0	0	0	4	5	3	14	12	22
Docile stock, non-hungry	1	21	20	6	7	0	1	3	1
Flighty stock, deprived	0	0	3	0	0	2	17	5	33
Docile stock, deprived	6	22	21	2	2	0	1	0	0

b. Removal from experimental cage

CLASS	RESPONSE SCORE								
	1	2	3	4	5	6	7	8	9
Flighty stock, non-hungry	0	3	4	1	3	0	10	27	12
Docile stock, non-hungry	1	22	17	14	1	0	1	3	1
Flighty stock, deprived	0	2	0	0	0	0	11	24	23
Docile stock, deprived	3	32	8	8	1	0	0	2	0

Table D 9

Exp D 1

The responses of 7-month old birds when being removed by the Experimenter from (a) the home battery cage and (b) the experimental cage, on each of 6 consecutive days.

Stage 4. Experimenter reaches for bird.

The daily mean ± SE response scores obtained by birds in each stock-treatment class.

N = 10 birds in each class except the docile stock deprived in which N = 9.

CLASS	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Removal from home battery cage												
Flighty stock, non-hungry	7.9	0.4	8.3	0.3	7.5	0.5	7.1	0.6	7.2	0.6	7.1	0.5
Docile stock, non-hungry	3.4	0.6	3.4	0.7	3.2	0.4	3.7	0.7	3.2	0.4	3.3	0.6
Flighty stock, deprived	7.5	0.6	8.3	0.3	8.1	0.4	8.0	0.6	8.1	0.3	7.8	0.6
Docile stock, deprived	2.4	0.2	3.2	0.6	2.6	0.4	2.4	0.4	2.3	0.3	2.3	0.2
Removal from experimental cage												
Flighty stock, non-hungry	8.5	0.2	8.4	0.1	7.2	0.6	5.8	0.8	6.5	0.7	6.7	0.7
Docile stock, non-hungry	4.6	0.9	3.0	0.3	3.5	0.6	2.8	0.3	2.8	0.3	3.0	0.3
Flighty stock, deprived	8.4	0.2	8.3	0.2	7.6	0.6	7.5	0.7	8.1	0.3	8.1	0.3
Docile stock, deprived	3.8	0.9	2.9	0.3	3.0	0.3	2.2	0.3	2.1	0.1	2.0	0.2

Table D 11

Exp D 2

The responses of chicks when being removed by the Experimenter from (a) the home box and (b) the experimental box, on each of 6 consecutive days.

Stage 1. Experimenter stands at box.

The number of chicks in each stock-treatment class assigned each of the four possible response scores over the total 6 days.

N = 10 chicks in each class.

a. Removal from home box

CLASS	RESPONSE SCORE			
	1	2	3	4
Flighty stock, non-hungry	0	5	50	5
Docile stock, non-hungry	0	7	47	6
Flighty stock, deprived	0	7	49	4
Docile stock, deprived	1	7	52	0

b. Removal from experimental box

CLASS	RESPONSE SCORE			
	1	2	3	4
Flighty stock, non-hungry	0	11	47	2
Docile stock, non-hungry	0	8	50	2
Flighty stock, deprived	0	2	53	5
Docile stock, deprived	0	7	53	0

Table D 12 Exp D 2

The responses of chicks when being removed by the Experimenter from (a) the home box and (b) the experimental box, on each of 6 consecutive days.

Stage 1. Experimenter stands at box.

The daily mean $\pm$ response scores obtained by chicks in each stock-treatment class.

N = 10 chicks in each class.

CLASS	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Removal from home box												
Flighty stock, non-hungry	2.8	0.1	2.9	0.1	3.1	0.1	3.0	0.2	3.1	0.2	3.1	0.1
Docile stock, non-hungry	3.1	0.1	3.1	0.1	3.0	0.2	2.9	0.1	3.1	0.1	3.0	0.2
Flighty stock, deprived	2.7	0.2	2.9	0.2	3.0	0.2	3.1	0.1	3.1	0.1	2.9	0.1
Docile stock, deprived	3.0	0.0	3.8	0.1	2.8	0.1	2.9	0.1	2.8	0.1	2.8	0.2
Removal from experimental box												
Flighty stock, non-hungry	2.9	0.1	2.9	0.1	2.9	0.2	2.7	0.2	2.9	0.1	2.9	0.2
Docile stock, non-hungry	2.8	0.1	3.0	0.2	2.9	0.1	3.0	0.2	2.9	0.1	2.8	0.1
Flighty stock, deprived	3.2	0.1	3.0	0.2	3.0	0.0	3.0	0.1	3.0	0.2	3.0	0.0
Docile stock, deprived	2.8	0.1	3.0	0.0	2.7	0.2	3.0	0.0	2.9	0.1	2.9	0.1

Table D 13 Exp D 2

The responses of chicks when being removed by the Experimenter from (a) the home box and (b) the experimental box, on each of 6 consecutive days.

Stage 2. Experimenter places hand in box.

The number of chicks in each stock-treatment class assigned each of the eight possible response scores over the total 6 days.

N = 10 chicks in each class.

a. Removal from home box

CLASS	RESPONSE SCORE							
	1	2	3	4	5	6	7	8
Flighty stock, non-hungry	0	2	44	4	1	3	4	2
Docile stock, non-hungry	0	3	50	5	2	0	0	0
Flighty stock, deprived	2	2	36	7	4	5	4	0
Docile stock, deprived	19	15	25	0	0	1	0	0

b. Removal from experimental box

CLASS	RESPONSE SCORE							
	1	2	3	4	5	6	7	8
Flighty stock, non-hungry	0	3	36	2	7	8	2	2
Docile stock, non-hungry	0	5	51	3	1	0	0	0
Flighty stock, deprived	0	1	39	9	0	5	6	0
Docile stock, deprived	5	7	47	0	0	1	0	0

Table D 14

The responses of chicks when being removed by the Experimenter from (a) the home box and (b) the experimental box, on **each** of 6 consecutive days.

Stage 2. Experimenter places hand in box.

The daily mean $\pm$ SE response scores obtained by chicks in each stock-treatment class.

N = 10 chicks in each class.

CLASS	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Removal from home box												
Flighty stock, non-hungry	3.0	0.3	3.3	0.3	3.1	0.1	4.8	0.7	3.5	0.3	4.2	0.6
Docile stock, non-hungry	3.1	0.1	3.1	0.1	3.0	0.2	2.9	0.1	3.2	0.2	3.1	0.2
Flighty stock, deprived	3.4	0.4	3.9	0.5	4.1	0.4	3.9	0.4	3.1	0.1	3.6	0.7
Docile stock, deprived	3.0	0.0	3.0	0.4	2.4	0.2	1.9	0.3	1.5	0.2	1.2	0.1
Removal from experimental box												
Flighty stock, non-hungry	3.5	0.3	3.6	0.4	3.9	0.4	4.6	0.6	4.0	0.6	3.9	0.5
Docile stock, non-hungry	2.8	0.1	3.0	0.2	3.0	0.0	3.1	0.1	3.2	0.3	2.9	0.1
Flighty stock, deprived	3.2	0.1	3.8	0.5	3.4	0.4	4.4	0.5	4.2	0.6	3.7	0.4
Docile stock, deprived	3.2	0.3	3.0	0.0	2.8	0.1	2.7	0.2	2.5	0.3	2.4	0.3

Table D 15

Exp D 2

The responses of chicks when being removed by the Experimenter from (a) the home box and (b) the experimental box, on each of 6 consecutive days.

Stage 3. Experimenter reaches for chick.

The number of chicks in each stock-treatment class assigned each of the eight possible response scores over the total 6 days.

N = 10 chicks in each class.

a. Removal from home box

CLASS	RESPONSE SCORE							
	1	2	3	4	5	6	7	8
Flighty stock, non-hungry	0	1	18	3	8	21	3	6
Docile stock, non-hungry	0	2	48	6	3	1	0	0
Flighty stock, deprived	0	5	18	11	4	14	1	7
Docile stock, deprived	1	33	19	0	5	2	0	0

b. Removal from experimental box

CLASS	RESPONSE SCORE							
	1	2	3	4	5	6	7	8
Flighty stock, non-hungry	0	3	19	5	6	19	2	6
Docile stock, non-hungry	1	5	43	3	7	1	0	0
Flighty stock, deprived	0	1	18	7	2	19	8	5
Docile stock, deprived	0	8	45	0	6	1	0	0

Table D 16

The responses of chicks when being removed by the Experimenter from (a) the home box and (b) the experimental box, on each of 6 consecutive days.

Stage 3. Experimenter reaches for chick.

The daily mean $\pm$ SE response scores obtained by chicks in each stock-treatment class

N = 10 chicks in each class.

CLASS	Day 1		Day 2		Day 3		Day 4		Day 5		Day 6	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Removal from home box												
Flighty stock, non-hungry	3.8	0.4	4.9	0.6	5.3	0.6	6.0	0.6	5.3	0.4	5.0	0.4
Docile stock, non-hungry	3.1	0.1	3.4	0.3	3.0	0.2	3.0	0.0	3.5	0.3	3.3	0.3
Flighty stock, deprived	3.6	0.4	4.5	0.7	5.0	0.5	4.6	0.6	4.9	0.6	4.9	0.6
Docile stock, deprived	2.8	0.2	3.4	0.5	2.4	0.2	2.8	0.5	2.7	0.4	2.3	0.3
Removal from experimental box												
Flighty stock, non-hungry	4.3	0.5	4.8	0.6	5.1	0.5	4.4	0.4	5.5	0.7	4.8	0.7
Docile stock, non-hungry	3.1	0.4	3.3	0.4	3.4	0.3	3.3	0.2	2.9	0.2	3.3	0.3
Flighty stock, deprived	5.3	0.6	4.7	0.6	5.1	0.6	5.3	0.7	5.1	0.5	4.9	0.5
Docile stock, deprived	4.4	0.5	3.2	0.2	2.8	0.1	3.2	0.2	5.2	0.3	3.1	0.4

Table D 18

Exp D 3

Behaviour of Seen and of Unseen reared birds placed in isolation in a cage in the sound-proof room at 6 weeks of age.
The number of birds in each stock-rearing class which, during a 900s observation, performed each of the behaviour patterns listed below.
Statistical analysis by the χ^2 Test using Cochran's (1954) modification.
N = 15 in each class.

STOCK	FLIGHTY		DOCILE		p <	
REARING	SEEN	UNSEEN	SEEN	UNSEEN	STOCK	REARING
Time spent:						
Lying	15	15	15	15		
Eyes closed	11	9	10	8		
Beak on ground	5	2	5	3		
Walking	5	5	7	6		
Panting	4	0	1	4		
Peeping	4	1	12	7	0.001	0.01
Incidences of:						
Change stance	10	7	11	8		
Preen	4	2	4	0		
Peck environment	1	0	3	1		
Comfort movement	3	2	2	2		
Yawn	2	4	3	2		
Nibble	6	4	7	6		
Defaecation	7	5	10	6		

Table D 19

Exp D 3

Behaviour of 6-week old Seen or Unseen reared birds isolated in a cage in a sound-proof room for 900s.

The mean $\pm$ SE time (in seconds) or incidences of performance of each of the bahaviour patterns listed below, by birds in each stock rearing class; with statistical analysis by the analysis of variance.

N = 15 in each class.

STOCK	FLIGHTY				DOCILE			
REARING	SEEN		UNSEEN		SEEN		UNSEEN	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
Time spent:								
Lying	660.1	67.7	751.1	58.2	680.3	62.6	759.2	61.6
Eyes closed	123.4	38.2	64.3	25.8	168.7	58.6	49.4	20.5
Incidences of:								
Change stance	1.5	0.5	0.8	0.3	1.7	0.4	1.0	0.3
Defaecate	0.8	0.3	0.6	0.3	1.1	0.3	0.9	0.3

SOURCE OF VARIATION	STOCK	REARING	S x R
DEGREES OF FREEDOM	1	1	1
	VARIANCE RATIOS		
Lying	0.05	1.84	0.01
Eyes closed	0.16	5.33 *	0.61
Change stance	0.26	2.91	0.03
Defaecate	1.78	3.66	3.01

Residual degrees of freedom = 56

* $p < 0.05$

Table D 20 Exp D 3

Behaviour of Seen and of Unseen reared birds placed in isolation in a cage in the sound-proof room at 6 weeks of age.

The number of birds in each stock-rearing class which responded, at each stage of approach by the Experimenter, in each of the ways listed below.

Statistical analysis by the χ^2 Test using Cochran's (1954) modification.

N = 15 in each class.

STOCK	FLIGHTY		DOCILE		p <	
REARING	SEEN	UNSEEN	SEEN	UNSEEN	STOCK	REARING
E Appears						
Stand still	13	8	15	9		0.001
Withdraw	2	7	0	6		
Hand on Cage						
Stand still	15	13	14	13		
Withdraw	0	2	1	2		
Open Cage						
Stand still	13	11	14	14		
Withdraw	2	4	1	1		
Reach Out						
Stand still	8	11	12	14	0.05	
Withdraw	7	4	3	1		

Table D 21

Behaviour of Seen and of Unseen reared birds when the Experimenter was present in the pen (Part A). Results for days 1-5 inclusive.

The daily mean ± SE total number of birds per cage of five birds which, during four successive observations occupied each part of the cage and performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.

N = 15 scores for each stock-treatment class.

	FLIGHTY STOCK				DOCILE STOCK				p <			
	SEEN		UNSEEN		SEEN		UNSEEN		S F v. S D	U F v. U D	S F v. U F	S D v. U D
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
Cage front	7.3	1.1	2.6	0.8	14.9	1.4	8.9	2.1	0.002	0.05	0.02	0.05
Cage middle	7.3	0.9	2.9	0.9	4.1	1.1	4.5	1.2			0.02	
Cage back	5.4	1.0	14.5	1.7	1.0	0.5	6.6	2.0	0.002	0.02	0.002	0.05
Stand	15.4	1.0	14.2	1.3	14.1	1.2	16.3	1.1				
Eat or drink	3.7	1.0	1.0	0.5	5.5	1.3	3.9	1.4				
Preen	1.7	0.6	1.1	0.4	0.7	0.2	1.5	0.5				
Huddle at back	0.4	0.3	4.4	1.9	0.0	0.0	2.8	1.6				
Doze	3.2	0.8	3.5	1.4	1.7	0.7	1.6	0.7				

Table D 22

Behaviour of Seen and of Unseen reared birds when the Experimenter stood in front of the cage for 30s (Part B) and then placed a hand on the cage for 30s (Part C).

Results for days 1-5 inclusive.

The daily mean ± SE total time (out of 150s) per cage of five birds that each part of the cage was occupied and the daily mean ± SE number of birds per cage which performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.

N = 15 scores for each stock-rearing class.

	FLIGHTY STOCK				DOCILE STOCK				P <			
	SEEN		UNSEEN		SEEN		UNSEEN		S F v. S D	U F v. U D	S F v. U F	S D v. U D
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
E at cage:												
Tm at front	56.7	9.8	4.0	2.7	114.7	13.2	42.0	14.0	0.02			0.002
Tm in middle	47.7	11.4	20.0	11.6	22.0	10.4	29.7	9.6	0.05			
Tm at back	45.6	11.2	126.0	13.2	13.3	6.2	78.3	17.8		0.02	0.002	0.05
No huddled at back	0.0	0.0	2.5	0.7	0.0	0.0	0.7	0.3			0.02	
Hand on cage:												
Tm at front	52.7	11.7	5.5	2.8	116.7	12.9	45.4	15.0	0.002	0.02	0.02	0.002
Tm in middle	34.0	12.0	24.0	11.8	22.6	10.8	17.4	6.7				
Tm at back	63.3	13.4	120.5	13.2	10.7	5.2	87.2	17.1	0.02		0.02	0.02
No huddled at back	0.0	0.0	1.7	0.6	0.0	0.0	0.7	0.4				
No with head out at front	0.0	0.0	0.0	0.0	0.7	0.3	0.1	0.1				

Table D 23

Behaviour of Seen and of Unseen reared birds when the Experimenter was present in the pen (Part A).
Results for days 6-10 inclusive.
The daily mean $\pm$ SE total number of birds per cage of five birds which, during four successive observations occupied each part of the cage and performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.
N = 15 scores for each stock-treatment class.

	FLIGHTY STOCK				DOCILE STOCK				p <			
	SEEN		UNSEEN		SEEN		UNSEEN		S F v. S D	U F v. U D	S F v. U F	S D v. U D
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
Cage front	8.0	0.9	6.2	0.9	14.1	1.2	14.2	0.8	0.002	0.002		
Cage middle	10.3	1.1	9.9	1.0	5.0	1.2	4.9	0.9	0.002	0.002		
Cage back	1.7	0.5	3.9	1.2	0.9	0.6	0.9	0.3				
Stand	14.1	1.2	11.9	1.4	14.1	1.0	15.1	0.9				
Eat or drink	5.5	0.8	3.7	1.0	7.5	1.2	6.1	1.2				
Preen	4.3	1.0	2.2	0.6	2.1	0.8	1.9	0.6				
Walk around	1.1	0.5	1.3	0.6	0.8	0.4	0.6	0.4				
Doze	3.4	0.9	5.8	1.0	2.1	0.6	2.3	0.6				

Table D 24

Behaviour of Seen and of Unseen reared birds when the Experimenter stood in front of the cage for 30s (Part B) and then placed a hand on the cage for 30s (Part C).

Results for days 6-10 inclusive.

The daily mean ± SE total time (out of 150s) per cage of five birds that each part of the cage was occupied and the daily mean ± SE number of birds per cage which performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.

N = 15 scores for each stock rearing class.

	FLIGHTY STOCK				DOCILE STOCK				p <			
	SEEN		UNSEEN		SEEN		UNSEEN		S F v. S D	U F v. U D	S F v. U F	S D v. U D
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
E at cage:												
Tm at front	69.1	10.5	28.0	6.2	118.6	8.4	99.6	11.9	0.02	0.002	0.02	
Tm in middle	69.4	10.6	53.0	11.7	21.2	8.0	22.1	6.7	0.02	0.05		
Tm at back	11.5	4.8	69.0	11.6	10.2	4.1	28.4	10.2		0.05	0.002	
No with head out at front	0.2	0.1	0.1	0.1	1.1	0.3	0.5	0.2				
Hand on cage:												
Tm at front	68.5	11.7	26.3	7.0	123.7	7.8	99.0	12.2	0.002	0.002	0.05	
Tm in middle	57.2	12.3	39.3	8.3	16.3	7.3	17.0	7.9	0.02	0.05		
Tm at back	24.3	10.3	84.4	11.5	10.0	3.8	34.0	11.8		0.02	0.002	
No with head out at front	0.2	0.1	0.1	0.1	0.7	0.2	0.6	0.3				
No pecking hand	0.1	0.1	0.0	0.0	0.7	0.2	0.6	0.2				

Table D 25 Exp D 4

Behaviour of Seen and of Unseen reared birds when the Experimenter was present in the pen (Part A).

Results for Days 12-16 inclusive.

The daily mean $\pm$ SE total number of birds per cage of five birds which, during four successive observations occupied each part of the cage and performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.

N = 15 scores for each stock treatment class.

	FLIGHTY STOCK				DOCILE STOCK				p <			
	SEEN		UNSEEN		SEEN		UNSEEN		S F v. S D	U F v. U D	S F v. U F	S D v. U D
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
Cage front	7.7	0.9	4.6	0.9	9.7	1.5	11.8	1.3		0.002	0.05	
Cage middle	10.1	1.2	10.8	1.5	8.9	1.5	7.7	1.3				
Cage back	2.2	0.9	4.6	1.2	1.4	0.6	0.5	0.2		0.002		
Stand	15.1	1.2	13.5	1.3	15.1	1.1	18.1	0.7		0.002		
Eat or drink	4.1	1.0	3.3	0.8	4.8	1.2	7.1	1.2				
Preen	2.5	0.6	2.5	0.6	2.6	0.8	1.7	0.6		0.05		
Walk around	3.5	0.8	4.5	1.2	4.1	1.0	4.4	0.9				
Doze	2.0	1.0	4.5	1.3	1.7	0.5	1.1	0.6		0.02		

Table D 26

Behaviour of Seen and of Unseen reared birds when the Experimenter stood in front of the cage for 30s (Part B) and then placed a hand on the cage for 30s (Part C).

Results for days 12-16 inclusive.

The daily mean ± SE total time (out of 150s) per cage of five birds that each part of the cage was occupied and the daily mean ± SE number of birds per cage which performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.

N = 15 scores for each stock-rearing class.

	FLIGHTY STOCK				DOCILE STOCK				p <			
	SEEN		UNSEEN		SEEN		UNSEEN		S F v. S D	U F v. U D	S F v. U F	S D v. U D
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
E at cage:												
Tm at front	87.3	11.9	37.9	7.8	134.4	8.0	112.7	13.1	0.02	0.002	0.05	
Tm in middle	34.0	12.0	18.0	7.6	9.6	6.7	24.0	8.9				
Tm at back	28.7	9.3	94.1	10.4	6.0	13.3	13.3	5.7		0.002	0.002	
No with head out at front	0.1	0.1	0.2	0.1	2.4	0.4	0.8	0.4				0.05
Hand on cage:												
Tm at front	56.7	11.5	17.0	5.2	133.1	6.9	108.3	12.0	0.002	0.002	0.05	
Tm in middle	55.3	14.9	25.7	8.1	12.0	6.4	18.7	7.4	0.02			
Tm at back	38.0	8.4	107.3	12.9	4.9	2.8	23.0	9.0	0.02	0.002	0.002	
No with head out at front	0.0	0.0	0.0	0.0	0.7	0.3	0.8	0.5				
No pecking hand	0.2	0.1	0.1	0.1	1.1	0.2	0.4	0.2				0.05

Table D 27

Behaviour of Seen and of Unseen reared birds when the Experimenter was present in the pen (Part A).

Results for days 17-21 inclusive.

The daily mean $\pm$ SE total number of birds per cage of five birds which, during four successive observations occupied each part of the cage and performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.

N = 15 scores for each stock treatment class.

	FLIGHTY STOCK				DOCILE STOCK				p <			
	SEEN		UNSEEN		SEEN		UNSEEN		SF v. SD	UF v. UD	SF v. UF	SD v. UD
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
Cage front	7.1	1.1	4.4	0.9	14.3	1.4	14.1	1.3	0.002	0.002		
Cage middle	10.1	1.4	11.3	1.7	5.6	1.4	5.5	1.3		0.05		
Cage back	2.8	1.1	4.3	1.2	0.1	0.1	0.4	0.3		0.05		
Stand	13.1	1.4	12.2	1.5	17.1	1.0	18.5	0.6	0.05	0.002		
Eat or drink	4.6	0.9	3.7	0.8	8.5	1.2	7.8	1.3				
Preen	4.7	1.0	3.3	0.7	1.9	0.7	1.7	0.6				
Walk about	2.1	0.6	2.9	0.7	1.5	0.6	2.9	0.7				
Doze	2.4	0.7	4.7	1.4	1.0	0.6	0.3	0.3				
Head out at front of cage	0.3	0.2	0.0	0.0	3.5	1.2	1.9	0.7	0.05			0.05

Table D 28

Behaviour of Seen and Unseen reared birds when the Experimenter stood in front of the cage for 150s (Part B) and then placed a hand on the cage for 150s (Part C).

Results for days 17-21 inclusive.

The daily mean ± SE total time (out of 150s) per cage of five birds that each part of the cage was occupied and the daily mean ± SE number of birds per cage which performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.

N = 15 scores for each stock rearing class.

	FLIGHTY STOCK				DOCILE STOCK				p <			
	SEEN		UNSEEN		SEEN		UNSEEN		S F v. S D	U F v. U D	S F v. U F	S D v. U D
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
E at cage:												
Tm at front	49.0	8.8	26.7	6.8	126.5	8.7	114.0	9.2	0.002	0.002		
Tm in middle	40.0	11.0	27.3	7.5	16.0	8.7	14.5	5.4				
Tm at back	61.0	5.0	96.0	8.1	17.5	3.0	21.5	7.3	0.002	0.002	0.02	
No with head out at front	0.0	0.0	0.0	0.0	2.5	0.4	1.1	0.5				0.05
Hand on cage:												
Tm at front	39.8	6.5	14.7	5.6	140.0	3.8	121.3	8.9	0.002	0.002	0.02	
Tm in middle	32.7	12.1	14.0	6.5	6.0	3.2	10.7	5.3	0.02			
Tm at back	77.5	11.2	121.1	7.0	4.0	2.7	18.0	5.7	0.002	0.002	0.02	
No with head out at front	0.1	0.1	0.0	0.0	2.0	0.5	0.6	0.4				
No pecking hand	0.3	0.1	0.0	0.0	1.5	0.2	1.0	0.3				

Table D 29

Behaviour of Seen and of Unseen reared birds when the cage was open for 30s (Part D) and when the Experimenter waved a hand in front of the cage for 30s (Part E).

Results for days 11-15 inclusive.

The daily mean ± SE total time (out of 150s) per cage of five birds that each part of the cage was occupied and the daily mean ± SE number of birds per cage which performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.

N = 15 scores for each stock rearing class.

	FLIGHTY STOCK				DOCILE STOCK				p <			
	SEEN		UNSEEN		SEEN		UNSEEN		S F v. S D	U F v. U D	S F v. U F	S D v. U D
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
Cage open:												
Tm at front	34.0	7.5	16.0	8.3	109.7	10.4	64.7	13.9	0.002	0.02		0.05
Tm in middle	32.7	8.4	16.3	6.1	16.6	4.3	44.3	10.9				
Tm at back	83.3	7.6	117.7	9.6	23.7	10.2	41.0	11.8	0.002	0.002	0.02	
No coming out of cage	0.0	0.0	0.0	0.0	1.3	0.3	0.1	0.1				
No going to back of cage	2.0	0.3	1.1	0.4	1.1	0.4	1.5	0.4				
Wave hand:												
Tm at front	9.7	4.5	2.0	2.0	105.0	10.1	50.1	16.9	0.002	0.05		0.05
Tm in middle	18.0	8.2	6.0	3.2	21.1	4.8	38.0	10.6		0.02		
Tm at back	122.3	9.4	142.0	3.6	24.0	10.2	61.9	15.4	0.002	0.002		
No fixating hand	0.3	0.3	0.5	0.2	2.5	0.6	1.8	0.5				

Table D 29

Behaviour of Seen and of Unseen reared birds when the cage was open for 30s (Part D) and when the Experimenter waved a hand in front of the cage for 30s (Part E).

Results for days 11-15 inclusive.

The daily mean ± SE total time (out of 150s) per cage of five birds that each part of the cage was occupied and the daily mean ± SE number of birds per cage which performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.

N = 15 scores for each stock rearing class.

	FLIGHTY STOCK				DOCILE STOCK				p <			
	SEEN		UNSEEN		SEEN		UNSEEN		S F v. S D	U F v. U D	S F v. U F	S D v. U D
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
Cage open:												
Tm at front	34.0	7.5	16.0	8.3	109.7	10.4	64.7	13.9	0.002	0.02		0.05
Tm in middle	32.7	8.4	16.3	6.1	16.6	4.3	44.3	10.9				
Tm at back	83.3	7.6	117.7	9.6	23.7	10.2	41.0	11.8	0.002	0.002	0.02	
No coming out of cage	0.0	0.0	0.0	0.0	1.3	0.3	0.1	0.1				
No going to back of cage	2.0	0.3	1.1	0.4	1.1	0.4	1.5	0.4				
Wave hand:												
Tm at front	9.7	4.5	2.0	2.0	105.0	10.1	50.1	16.9	0.002	0.05		0.05
Tm in middle	18.0	8.2	6.0	3.2	21.1	4.8	38.0	10.6		0.02		
Tm at back	122.3	9.4	142.0	3.6	24.0	10.2	61.9	15.4	0.002	0.002		
No fixating hand	0.3	0.3	0.5	0.2	2.5	0.6	1.8	0.5				
No panicking	0.0	0.0	1.7	0.6	0.0	0.0	0.0	0.0				

Table D 30

Behaviour of Seen and of Unseen reared birds when a novel object (windmill) was placed inside the cage for 120s (Part F).

Results for days 16-20 inclusive.

The daily mean ± SE total time (out of 600s) per cage of five birds that each part of the cage was occupied and the daily mean ± SE number of birds per cage which performed each of the other behaviour patterns listed below, with statistical analysis by the Mann-Whitney U-test, 2-tailed.

N = 15 scores for each stock-treatment class.

	FLIGHTY STOCK				DOCILE STOCK				p <			
	SEEN		UNSEEN		SEEN		UNSEEN		S F v. S D	U F v. U D	S F v. U F	S D v. U D
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE				
Tm at windmill	39.8	17.9	9.7	5.9	245.2	40.5	209.7	40.4	0.002	0.002		
Tm at front of cage	95.6	32.7	49.0	16.3	265.7	28.4	174.4	34.0	0.002	0.02		
No pecking windmill	0.2	0.1	0.0	0.0	2.8	0.4	1.7	0.4	0.002	0.02		
No panicking	1.0	0.5	1.3	0.6	0.0	0.0	2.1	0.5				
During first 5s of each day:												
No approaching	0.2	0.1	0.1	0.1	1.8	0.4	1.1	0.4	0.02	0.02		
No retreating	3.7	0.5	4.4	0.3	0.1	0.1	2.1	0.6	0.002	0.02		

Table E 1 Exp E 2

The responses of mature birds to the operation of the mechanical scraper in the battery unit, a stimulus to which the birds had been exposed daily for several months.

The number of birds in each stock which responded in each of the five different ways observed, when the scraper passed with blade up and then with blade down.

N = 72 in each stock.

RESPONSE	BLADE UP		BLADE DOWN	
	FLIGHTY STOCK	DOCILE STOCK	FLIGHTY STOCK	DOCILE STOCK
Jumping at walls	0	0	1	0
Clawing at walls	3	2	7	4
Steps on spot	13	9	18	5
No visible response	48	57	33	54
Looks at scraper	8	4	13	9

Table E 2 Exp E 3

The following response of chicks - Training session.
The number of chicks in each stock-rearing-training class which, during a 600s observation, performed each of the behaviour patterns listed below.
Statistical analysis by the χ^2 Test using Cochran's (1954) modification.
N = 16 in each class.

STOCK	FLIGHTY		DOCILE		p <	
REARING	SINGLE	PAIR	SINGLE	PAIR	STOCK	REARING
Time spent:						
Standing	15	15	15	14		
Lying	10	10	12	12		
Eyes closed	3	3	10	11	0.001	
Beak on ground	2	1	4	4		
Peeping	14	15	13	10		
Stand from model	16	16	16	16		
Follow model	2	3	8	5	0.05	
Flee model	2	1	0	0		
Random move	14	15	13	12		
At centre	16	16	16	16		
At path	12	11	10	8		
At wall	6	4	0	2		
Incidences of:						
Approach model	3	4	8	15	0.001	
Chase model	0	1	3	1		
Peck model	2	3	4	2		
Fixate model	14	12	15	15		
Attack model	0	0	1	0		
Peep	9	6	12	9		
Peck environment	9	10	14	8		
Peck feet	5	9	10	5		
Preen	2	3	2	0		
Comfort movement	8	3	11	3		0.001
Yawn	1	1	2	1		
Defaecation	12	11	5	5	0.01	
Jump at wall	3	0	0	0		

Table E 3 Exp E 3

Behaviour of chicks when being trained for 600s in the acquisition of a following response.
The mean ± SE time (in seconds) or incidences of performance of each of the behaviour patterns listed below, by chicks of each stock-rearing class; with statistical analysis by the analysis of variance.
N = 16 in each class.

STOCK	FLIGHTY				DOCILE				VARIANCE RATIOS		
REARING	SINGLE		PAIR		SINGLE		PAIR		STOCK	REARG	S x R
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE	1 d.f.	1 d.f.	1 d.f.
Time spent:											
Standing	454.7	49.8	458.7	43.8	395.8	62.2	334.3	60.7	2.25	0.13	0.59
Peeping	345.1	56.4	316.3	62.7	180.1	49.8	117.1	39.6	12.61***	0.67	0.07
Stand from model	514.7	37.3	524.7	18.6	553.1	17.1	570.6	13.4	0.72	1.58	0.09
Moving at random	64.7	34.2	34.9	13.7	14.9	3.5	21.4	12.0	2.60	0.34	0.89
At centre	346.7	56.4	381.5	52.8	379.7	46.0	439.3	46.1	0.72	1.58	0.09
In model's path	186.6	48.3	182.3	47.6	220.3	46.0	138.6	38.7	0.01	0.90	0.73
Incidences of:											
Fixating model	3.5	0.7	2.2	0.5	3.9	0.5	2.2	0.4	0.12	7.92**	0.12
Pecking environment	3.9	1.5	2.2	0.6	8.6	2.4	4.8	1.6	2.56	1.15	1.07
Sections crossed when moving at random	26.8	10.7	26.2	10.5	9.9	2.6	9.3	3.6	4.65*	0.01	0.00

Residual degrees of freedom = 60. * p < 0.05 ** p < 0.01 *** p < 0.001

Table E4 Exp E 3

The following response of chicks - Testing session.

The number of chicks in each stock-rearing-training class which, during a 600s observation, performed each of the behaviour patterns listed below.

Statistical analysis by the χ^2 Test using Cochran's (1954) modification.

N = 16 in each class.

STOCK	FLIGHTY				DOCILE				p <		
REARING	SINGLE		PAIR		SINGLE		PAIR				
TRAINING	+	-	+	-	+	-	+	-	STOCK	REAR	TRAIN
Time spent:											
Standing	16	15	13	15	16	16	14	15			
Lying	3	7	8	10	4	7	10	6		0.05	
Eyes closed	1	4	10	4	4	3	0	6			
Beak on ground	0	2	5	1	3	2	6	2			
Peeping	14	15	12	15	11	15	14	14			
Stand from model	16	16	16	16	16	16	16	16			
Stand with model	14	11	5	0	14	13	6	6		0.001	
Follow model	13	12	5	3	13	12	4	6		0.001	
Total with model	14	12	6	3	14	13	7	6		0.001	
Flee model	0	0	0	2	0	0	0	0			
Random move	12	13	10	11	12	15	10	15			
At centre	15	16	14	16	13	16	15	16			
At path	15	12	7	4	14	12	9	12		0.001	
At wall	5	1	2	7	0	0	0	2	0.001		
Incidences of:											
Approach model	14	12	6	3	14	13	5	8		0.001	
Chase model	0	2	1	0	8	7	3	3	0.001		
Peck model	14	10	5	1	13	12	5	7		0.001	
Fixate model	7	5	6	7	8	12	10	10	0.01		
Attack model	0	1	0	1	6	1	0	1			
Peep	8	12	8	8	9	9	10	5			
Peck environment	15	9	4	1	14	13	6	9	0.05	0.001	
Peck feet	6	5	3	1	10	7	1	5			
Preen	4	3	3	0	7	6	3	0			
Comfort movement	13	8	5	2	14	7	4	10		0.001	
Yawn	2	1	2	0	2	1	3	1			
Defaecate	9	8	6	8	8	6	6	11			
Jump at wall	1	3	0	3	0	0	0	1			

Table E 5 (page 1) Exp E 3

Behaviour of chicks when being tested for 600s for the acquisition of a following response. The mean ± SE time (in seconds) or incidences of performance of each of the behaviour patterns listed below, by chicks of each stock-training-rearing class.

N = 16 in each class.

STOCK		FLIGHTY				DOCILE			
REARING		SINGLE		PAIR		SINGLE		PAIR	
TRAINING		+	-	+	-	+	-	+	-
Time spent:									
Standing	$\bar{x}$	589.6	521.9	456.1	427.5	583.9	552.8	425.0	521.8
	SE	8.7	40.0	58.8	55.9	11.5	22.4	58.9	39.9
Peeping	$\bar{x}$	169.4	208.6	175.7	232.2	72.7	189.9	225.5	264.4
	SE	39.7	52.3	49.6	58.7	28.9	41.5	47.0	51.5
Stand from model	$\bar{x}$	264.1	277.1	536.4	553.6	258.6	313.2	498.3	531.7
	SE	40.6	45.6	27.3	15.1	50.8	48.7	41.7	17.7
Moving at random	$\bar{x}$	41.0	31.5	11.6	45.4	7.7	17.2	6.8	20.0
	SE	29.7	13.2	6.7	14.9	2.2	4.7	2.3	5.9
At centre	$\bar{x}$	174.6	172.4	422.9	67.6	138.4	219.4	348.6	295.7
	SE	41.0	44.0	58.2	61.9	55.2	56.5	64.8	52.8
In model's path	$\bar{x}$	376.5	318.1	141.8	79.6	138.4	380.6	251.4	239.9
	SE	44.8	55.6	51.7	47.9	55.2	56.5	64.9	49.8

Table E5 (page 2) Exp E 3

STOCK		FLIGHTY				DOCILE			
REARING		SINGLE		PAIR		SINGLE		PAIR	
TRAINING		+	-	+	-	+	-	+	-
Latency to approach model	$\bar{x}$	207.3	289.9	449.0	591.3	138.9	237.9	460.8	514.3
	SE	49.5	56.1	58.2	5.9	16.7	57.8	58.4	25.5
Sections crossed when moving at random.	$\bar{x}$	18.9	64.1	6.8	45.1	4.7	17.6	5.8	15.7
	SE	11.5	35.5	3.2	15.4	1.4	5.3	2.1	5.6
Sections crossed when following model.	$\bar{x}$	30.7	29.2	1.8	0.4	40.3	30.8	9.6	4.2
	SE	6.9	6.8	0.6	0.2	7.6	6.2	5.5	0.7
Incidences of defaecation	$\bar{x}$	0.7	0.6	0.4	0.6	0.6	0.4	0.6	1.0
	SE	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2
No of pecks at model	$\bar{x}$	17.7	16.2	1.1	0.1	15.4	8.0	1.2	1.7
	SE	3.4	4.9	0.6	0.1	4.4	1.7	0.6	0.8

Table E 5 (page 3) Exp E 3

STOCK		FLIGHTY				DOCILE			
REARING		SINGLE		PAIR		SINGLE		PAIR	
TRAINING		+	-	+	-	+	-	+	-
Total time with model	$\bar{x}$	294.9	241.6	51.4	0.4	333.4	258.9	94.9	48.3
	SE	44.8	51.8	26.4	0.2	50.9	46.8	42.3	17.2
No of pecks at environment	$\bar{x}$	10.9	4.4	1.4	0.1	10.8	7.8	0.9	2.6
	SE	2.6	1.4	0.6	0.1	2.5	1.9	0.4	1.1
No of comfort movements	$\bar{x}$	1.1	0.7	0.2	0.1	1.3	0.4	0.3	0.5
	SE	0.2	0.3	0.1	0.1	0.4	0.2	0.2	0.2
Total no of sections crossed	$\bar{x}$	51.7	93.4	11.9	45.8	44.9	47.7	15.5	19.9
	SE	10.4	32.7	4.5	15.3	7.7	7.2	5.4	5.8
Incidences of fixating model	$\bar{x}$	0.7	0.5	0.6	0.5	0.9	1.2	1.6	2.0
	SE	0.3	0.2	0.2	0.2	0.3	0.2	0.4	0.6

Table E 6 Exp E 3

Behaviour of chicks when being tested for the acquisition of a following response.

Results of the analysis of variance of the main effects (stock, training and rearing) and their interactions, on the times or incidences of performance of the behaviour patterns listed below. If the actual numbers of chicks performing any behaviour pattern were significantly different no analysis of times or incidences was carried out and the letter N has been entered in the table below.

SOURCE OF VARIATION	STOCK	TRAING	REARG	S x T	S x R	T x R
DEGREES OF FREEDOM	1	1	1	1	1	1
	VARIANCE RATIOS					
Time spent:						
Standing	0.56	0.07	12.53 ***	1.88	0.10	2.01
Peeping	0.86	6.54 *	6.75 **	0.05	0.63	0.05
Total with model	1.78	4.17 *	N	0.02	0.10	0.07
Standing from model	0.03	1.47	87.70 ***	0.41	0.91	0.07
At centre	0.77	0.04	22.33 ***	0.31	1.04	1.47
In model's path	7.62 **	1.98	N	0.03	0.66	0.19
Moving at random	5.35 *	3.09	1.30	0.88	1.47	0.00
Latency to approach model	1.78	7.34 **	67.05 ***	0.27	0.16	0.01
Incidences of:						
Peck model	1.27	1.49	N	0.31	2.49	1.19
Peck environment	N	4.16 *	N	2.11	0.09	4.75 *
Comfort movements	0.01	4.55 *	N	0.50	2.74	6.80 **
Total no of sections crossed	3.55	4.26 *	13.22 ***	2.91	0.59	0.02
Sections crossed when moving at random	4.93 *	6.73 *	0.60	2.19	0.55	0.06

Residual degrees of freedom = 121

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

GLOSSARY OF TERMS

LITTER PECKING See Kruijt (1964) 'ground-scratching'.
A combination of pecking and scratching at the floor litter. If undisturbed, birds of all ages usually spend at least 3 - 4 min in this activity without stopping and mature birds often very much longer.

PECK ENVIRONMENT Any pecks not directed at the food, at other birds, or made while litter pecking. Usually these pecks were made at spots on the wall or at the cage bars; only one or two pecks were involved and each was counted separately.

COMFORT MOVEMENT Shaking, scratching or stretching any part of the body. See Kruijt (1964) for motor components of these movements.

DUST BATHING See Kruijt (1964).

DOZING A bird alternately opened and closed its eyes, remaining in each stage for app. 5 - 45 s. The total time spent both with eyes open and with eyes closed was counted as dozing. It was commonly followed by sleeping, characterised by the 'head behind wing' posture, or sometimes by preening.

ESCAPE MOVEMENTS Exaggerated up and down, and sideways movements of the head and neck made by a bird standing very close to and facing out of the bars of its cage or the wall of its pen.

WARY STEPS A bird held each foot in the air between steps for a period longer than is normal.

CHANGE STANCE A change from standing to lying or vice versa.

CHANGE DIRECTION A change from facing the front of a cage or box to facing the back or a side or vice versa.

AGGRESSION The behaviour of attack and threat. A bird being aggressive would show attack or threat behaviour, where threat is behaviour indicating intent to attack.

VOCALIZATIONS

N.B. Wood-Gush (1971) points out that the classification of domestic fowl calls is an area requiring much attention.

ALARM CALL The ground predator warning of Collias and Joos (1953) which they describe as cut - - - - - - cut-cut-cut-KAAAAH.

CLUCK Sounds exactly like the alarm call except that the bird remains silent at the end of each phrase instead of giving the KAAAAH call.

SQUAWK The fear squawk of Collias and Joos (1953).

SOFT CALL Sounds like the pre-laying call of Wood-Gush (1971).